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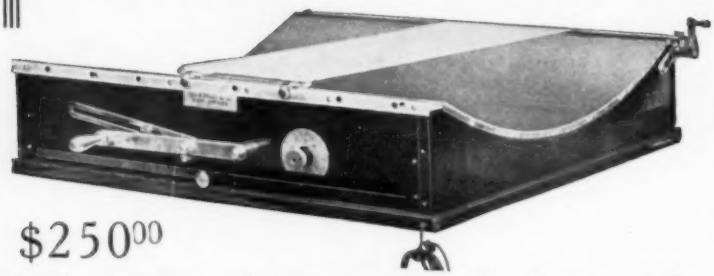

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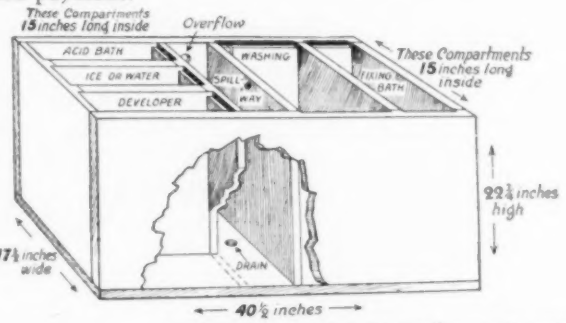

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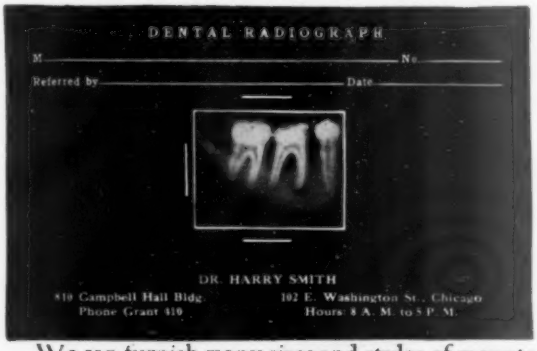

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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SOME BIOLOGICAL ASPECTS OF THE RADIATION THERAPY OF CANCER*

BY CLAUDE REGAUD, M.D.

PARIS, FRANCE

RADIOPHYSIOLOGY is for radiotherapy as important a factor of progress as the physical technique of radiation. Some of the discoveries made in radiobiological experimental laboratories are little known, though old and definitely established. They constitute nevertheless one of the scientific bases of the radiation treatment of cancer. They will exercise upon the future development of this branch of medicine an influence out of proportion with the obscure place they now occupy in the vast literature of radiotherapy.

The American Radium Society and its President, Dr. James T. Case, have given me the opportunity to present to this audience, composed of distinguished radiologists and surgeons, some of the ideas that are guiding the work of the Radium Institute of Paris. I wish to thank you, Mr. President and honored colleagues, very cordially.

Evidently it is impossible in a short talk to include all the important facts which it would be necessary to consider for a proper radiological introduction to radiotherapy. Being compelled to make a restricted choice, I shall undertake to analyze, as an example, the phenomena caused in the testicles of mammals by the *x*- and gamma rays; then, to show what conclusions we can draw from these phenomena, parallel to those which are taking place in an irradiated cancer, and finally, to give a brief resumé of the rules which at present seem to be forced upon radiotherapy by radiophysiology.

PHENOMENA PRODUCED BY X- AND GAMMA RAYS IN THE ACTIVE TESTICLES OF MAMMALS

It is well known that Albers-Schönberg had the idea, first in 1903, that *x*-rays caused sterility in animals on account of a special radiosusceptibility of the testes. This idea was proved to be correct soon after by the histological researches of several German experimenters. Bergonie and Tribondeau in 1905 and 1906 made important contributions bearing on this question. Since 1906 my collaborators, Blanc and Nogier, and I have made a very careful study of the modifications in spermatogenesis produced by radiation. We have been able, therefore, to learn their mechanism.

X- and gamma rays are capable of producing the same effects if a suitable technique is employed. However, gamma rays exhibit a more delicate selective action.

The first experimenters, including Bergonie, Tribondeau, Regaud and Blanc, had employed unfiltered *x*-rays of small penetration. They did not succeed in obtaining equal effects in the whole organ. Furthermore, to the selective phenomena occurring in the seminal epithelium, there was added a diffused caustic action involving all other tissues.

* An address delivered before THE AMERICAN RADIUM SOCIETY at its Ninth Annual Meeting at Chicago, Ill., June 9–10, 1924.

The utilization since 1909 of more penetrating *x*-rays screened by aluminum filters of increasing thickness has enabled Nogier and myself to produce effects of a selectivity unknown until that time. In our experiments we used testes varying in size from those of a rat to those of a ram (which weigh from 100 to 150 grams), which may be compared from this point of view to a human tumor. We succeeded in limiting the lethal action of the *x*-rays to those cells in the seminal tubules which are called spermatogones. These cells are situated at the base of the epithelium next to the connective membrane which envelops the seminal tubes. Being the ancestors of all the seminal cells, the spermatogonia are absolutely necessary for their renovation. If they are all destroyed, the epithelium becomes depleted gradually by successive elimination of all the surviving cells and then sterility is complete and final.

If a very penetrating radiation is employed and the dose is just sufficient, one can destroy all the spermatogonia in a testis, without causing any apparent effect, not only in the other tissues but also in the several generations of cells derived from the spermatogonia, including the spermatozoids, which are at the end of the spermatic line.

Now since the spermatogonia do not represent even a thousandth part of the weight of the testis, this radiophysiological result is typical of a selective effect of radiation.

Beginning from the moment of irradiation to about the thirtieth day at the latest, serial examinations show a progressive depletion of the epithelium and finally a complete and final disappearance of all seminal cells.

If the dose of radiation has been insufficient, some spermatogonia will survive. They suffice to repopulate either partially or completely, the seminal tubes in two or three months following irradiation.

The descendants of the spermatogonia in the first, second, and other generations are not absolutely insensitive to the rays. They may be killed when the radiation catches them at the time of subdivision. After a somewhat heavy dose, their subdivisions are abnormal and result in malformed elements, subject to spontaneous death.

The hereditary substance of the spermatozoids contained in the chromatin, is injured by the rays even though one cannot observe morphological changes. The eggs fertilized by these spermatozoids result in abortion or produce monsters (Bardeen, Regaud and Dubreuil, Hetwig).

The spermatogonia, which are extremely radiosensitive in an individual in full spermatogenic activity, are refractory in the immature animal in which the reproductive activity of the cells has not begun (Regaud and Dubreuil).

These facts, carefully verified, lead to the following conclusions:

There really exists, not only between different organs, between different tissues of the same organ, between different cell types of the same tissue, but also between the different physiological phases of the same cellular species, differences in radiosensitivity.

As pointed out for the first time by Perthes (1903) *the time of cellular division is the moment of greatest radiosensibility* of a cell.

As pointed out first by Bohn (1904) the chromatin in which the hereditary properties are mainly carried, is also the radiosensitive part of the cell.

The difference in radiosensitivity between cellular species and the radiosensitivity which is particularly pronounced in cells in the act of division or about to divide, form the fundamental basis on which rests the selective destruction of cells by radiation.

These facts which for a long time, and appropriately, have been applied to the radiotherapy of cancer, are and must remain one of the bases of this science.

To destroy a process of cellular multiplication, it is sufficient to destroy only the cells which are at the origin of the lines of descent, and which have the function of perpetuating the germ cells. This is true, no matter how few these cells may be, no matter how small may be the place which they occupy in the total mass of a tissue (Regaud).

The mother cells having disappeared, the multiplication process is suppressed.

Some time (latent period of radio-lesions) is required for the disappearance (by elimination in the case of the testis) of the lateral branches which have been spared.

This very important fact is strictly applicable to the cancer process. In many types of cancer, for example in the squamous-cell cancer, the cancerous tissue is reproduced without changes by the multiplication of the mother cells. These cells occupy the periphery of the cell cords or the lobules of the tumor tissue. There they are known as generating cells. *They are the only cells which are forever fertile.* All other cells of the cancer belong to lateral branches, of which the end-product is the horny squamous cell, which is sterile. It is useless to expect to kill all the cells of a squamous-cell cancer; it is sufficient to kill the mother cells. The others, which form practically the whole mass, disappear gradually by transformation and resorption.

When one compares the effects produced by highly filtered *x*-rays of greater and greater penetration, or better, the effects of the most penetrating gamma rays of radium, one observes a phenomenon, discovered by Nogier and myself, of the greatest importance. As the radiation becomes more penetrating, the diffuse necrotizing effects diminish, then practically disappear, and finally only the selective effects remain which are manifested in the most radiosensitive cells.

In diffuse caustic radiotherapy the selective effects will exist, but they are masked by the diffuse caustic action.

The selectivity of biologic action and the penetrating power are two properties of radiation which run together in the same sense.

The whole normal radiophysiology of skin, mucous membranes, ovary, lymphatic and hematopoietic tissues, and others, as well as the correct histologic interpretation of the effects of radiation on cancer, confirm entirely and without exception the truth of this principle.

It is the greater penetrating power and selectivity of action of the very penetrating gamma rays of radioactive substances, which is responsible for the therapeutic superiority of radium over *x*-rays in cancers of low radiosensitivity.

The most careful histologic study of normal radiophysiologic effects, particularly of the testis, leaves no doubt on the following point: *The effects are the same as if the rays acted directly on the sensitive cells.*

In a testis, an ovary (Lacassagne and Regaud), and a thymus (Cremieu and Regaud) sterilized by a selective radiation, there is no visible trace of a vascular lesion, nor is there a modification of the connective tissues. It is absolutely impossible to accept a dystrophy of vascular origin, a sclerosis of connective tissue, as immediate causes of the suffering and death of the sensitive cells. The same rule applies to cancer.

It is true that one can produce lesions in the vascular system and in connective tissue, either by increasing the dose of penetrating rays or by employing moderate doses of less penetrating rays. These effects are not essential and they are inconstant. They appear late when they exist. They are of some use in the palliative treatment of cancer, but they are not desirable when a cure is aimed at.

As regards the leucocytes, they at no time appear in the irradiated testis or ovary. They exert no influence in the skin, the thymus nor in irradiated cancer tissues, but subsequent to the death of the radiosensitive cells, leucocytes remove the debris.

The mechanism of the repopulation (testis, thymus, epidermis, etc.) *and of local recurrence* in cancer, following radiotherapy, is quite clear and well established. In every case histologic study shows that the *repopulation or the recurrence is derived from the mother cells which were spared.*

There are naturally some mother cells which have been spared in the less irradiated parts of a testis, of a cancer, treated by heterogeneous rays of unequal absorption.

There are also some mother cells which have been spared, even if the testis, or the cancer has been irradiated with the most homogeneous and most penetrating radiation possible, if the dose (per unit volume) has not been sufficient. The smaller the dose, the larger will be the number of mother cells which will survive.

There are, therefore, among these mother cells differences in sensitivity. Several reasons would lead us to think that these differences are in reality alternations. That is, the same cellular species may pass, according to a more or less regular rhythm through moments of sensitivity and resistance. Experience has verified this hypothesis and I have made therefrom a deduction of very great practical importance.

All other factors remaining the same, the duration of the treatment has an important bearing on the efficacy of a selective radiation. In other words, 1000 milligram-hours of radium, obtained by using 1000 mg. for one hour, 10 mg. for 100 hours, or 5 mg. for 200 hours will not give the same result.

I have made experiments first on the testicles, then on some cancers. The results are the same in both cases.

In the center of the ram's testicle, 15 dose units of heavily filtered emanation acting during a few hours only, produced a central necrosis without sterilizing the outer parts of the organ; in remarkable contrast, 3 dose units acting during fifteen days, have effected complete sterilization, but without central necrosis.

The same results have been obtained with cancers in general, and especially with the squamous-cell type; that is to say, the treatment has been more effective with the smaller quantity of radioactive substance applied during a longer time.

The following is my explanation of these results: In the testicle all the spermatogonia are acted upon at the time of their greatest radiosusceptibility, during their reproductive period, where a small quantity of radioactive substance is sufficient to kill them. These active reproductive periods are taking place successively and alternately in different places in the seminal tubes. It is, therefore, necessary for a small dose to be extended during the whole process to destroy all the spermatogonia.

Now, the microscope shows us that the same thing happens in the different parts of a squamous-cell cancer. This is a fact, and its importance will be more appreciated if I add that a change in our technique has allowed us for many years to obtain by the selective radiation treatment a greater proportion of cures with the squamous-cell than with the basal-cell cancers. There is no anatomical element absolutely resistant to radiation. With a sufficient dose every one can be destroyed.

All these anatomical elements, normal or neoplastic, are placed in three classes:

(*a*) The most susceptible are those that have preserved the capacity for reproduction. In this class we find the mother cells of the epithelial cancers. These, after having been killed by selective radiation, will be absorbed; their progeny are suppressed and the cancerous process they were causing will disappear.

(*b*) The differentiated cells (muscular, nervous, fixed connective, polynuclear leucocytes) are less susceptible. They are destroyed only by sufficient caustic radiation.

(*c*) The noncellular anatomical elements (plasma, fluids, connective and elastic fibers, fundamental bone and cartilaginous tissue) are not changed in their form by radiations, but they undergo an invisible and a latent physicochemical modification. If they have absorbed a sufficient amount of accumulative radiation, these noncellular elements will undergo a necrotic destruction, generally associated with simultaneous infection. Hence, in radiotherapy, it is necessary to reduce the lesions of the elements of the two last classes because they play a great part in the after-reactions, and because they are useless and produce pain and scars. These undesirable and dangerous lesions are generally produced by caustic rays or by an excess of selective and filtered radiation.

The observations on human cancers, treated by radiation, have revealed another most important conclusion: The progressive decrease in radiosusceptibility of the cancer cells treated by repeated nonsterilizing irradiations. These ineffective radiations will finally bring a necrosis of the treated region. This well-established fact forces us to adopt the rule of the single protracted treatment in human cancers.

The remarkable parallelism between the decreasing radiosusceptibility of cancer cells and the progressive alteration of the noncellular elements has induced me to

search for a connection between those two phenomena. I have recently brought in anew the old Werner hypothesis, which states that the susceptible cells are not directly acted upon by the rays, but that they are poisoned. I believe now that radiation liberates from the plasma or from the collagenous substance in which the cells lie an unknown poison which intoxicates the cells. Some experimental results obtained with cancer tissues from small animals irradiated *in vitro*, and then grafted (Wood and Prime) or grafted in connective tissue already irradiated (Murphy and co-workers, Nakahara) would receive perhaps by this hypothesis, a satisfactory explanation.

These constitute the more important radiophysiological facts that control, it seems to me, the radiation therapy of cancer.

CONCLUSIONS

1. The radiation treatment of cancer should utilize the selective action of the rays instead of their diffuse caustic effect.

2. The required selective action calls for more penetrating *x*-rays, for increased voltages and higher potential tubes.

3. Radium therapy should employ ultrapenetrating gamma rays, filtered by heavy metals, as recommended by Dominici in 1907.

The tube method is good, but not because it brings in the beta rays. It is inferior to the radium puncture method, with the resulting ultrapenetrating gamma rays. The latter technique has the advantage of reducing the diffused caustic effect, the serious after-reactions, and radio-necrosis.

4. The decreasing radiosusceptibility of the cancer cells treated by small ineffective and successive doses, imposes the necessity of the single continuous or discontinuous treatment.

5. The chronological distribution of this single complete treatment must be adapted to the life peculiarities of the cancerous tissue.

Generally the treatment is more effective if continuous and extended over six to ten days. This is particularly true for the epidermoid squamous-cell cancers. The roentgenotherapy of cancer will undoubtedly be benefited if all these rules are followed as closely as possible.

I wish to thank my colleagues, Drs. Ewing, Failla and Gendreau for the translation of this paper.

THE PHAGOCYTOSIS OF NUCLEAR MATERIAL (CHROMATIN) BY THE RETICULO-ENDOTHELIAL SYSTEM, THE KUPFFER CELLS IN PARTICULAR, AFTER INTENSIVE ROENTGEN IRRADIATION IN A CASE OF PRIMARY ABDOMINAL LYMPHOSARCOMA

BY ALDRED SCOTT WARTHIN, M.D.,

ANN ARBOR, MICHIGAN

AND JAMES T. CASE, M.D.,

BATTLE CREEK, MICHIGAN

IN a case of atypical Addison's pigmentation associated with primary aleucemic lymphocytoma (lymphosarcoma) of the retroperitoneal lymph-nodes involving the solar plexus and adrenals, with death occurring shortly after deep-seated intensive roentgen therapy, there was found, on microscopic study of the autopsy material, a degree of phagocytosis of nuclear chromatin by the entire reticulo-endothelial apparatus previously unrecorded in the literature. In the earliest experimental work on the effects of roentgen irradiation upon the spleen, lymph-nodes, and bone marrow carried on independently by Heineke and Warthin (1903–04) both observers noted the phagocytosis of disintegrating lymphocytes by the "endothelial cells" of the spleen pulp and of the sinuses of the lymph-nodes. In the illustrations given in Warthin's article[1] of the changes produced by irradiation of the spleen in white mice and

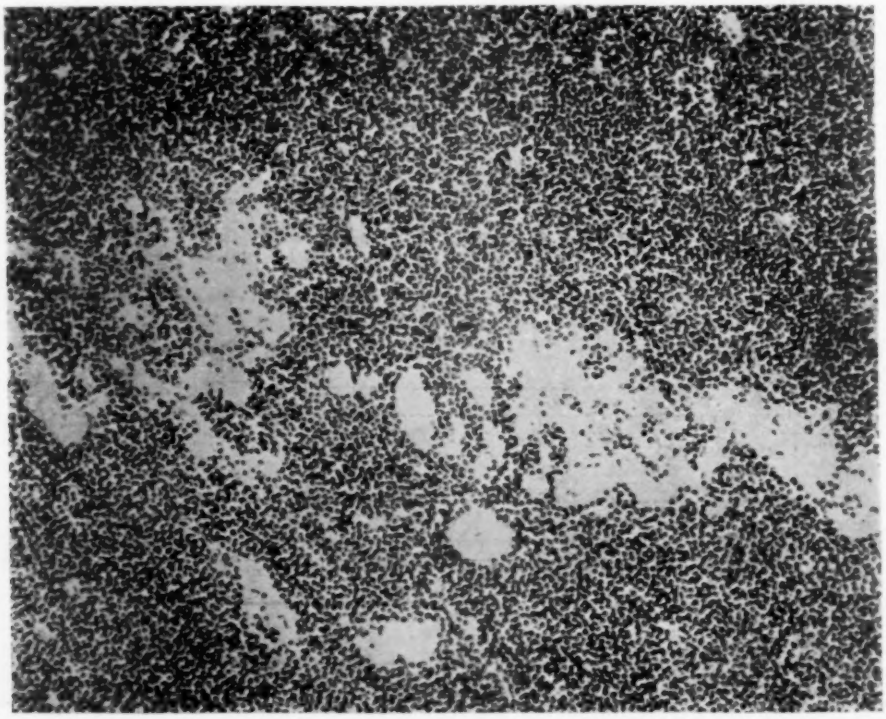

FIG. 1. Low power view of lymphosarcomatous retroperitoneal node, after deep roentgen irradiation. Areas of necrosis of the atypical lymphocytes. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length, 85 cm.

[1] WARTHIN, A. S. An experimental study of effects of roentgen rays upon the blood-forming organs, with especial reference to the treatment of leucemia. *Physician & Surg.*, 1907, xxix, 1–12; 69–87; 105–119.

rabbits (Figs. 7, 8) this phagocytosis of chromatin-particles was strikingly shown; and these observations have been repeatedly confirmed by later workers. In these reports, however, the participation of the entire reticulo-endothelial apparatus, the Kupffer cells of the liver, in particular, in the function of chromatin phagocytosis and disintegration has not attracted especial attention.

The term "reticulo-endothelial" has come within recent years to supplant the older term "endothelial" as applied to the phagocytic cells of the spleen pulp, bone marrow, sinus reticulum of lymph-nodes and hemolymph-nodes, Kupffer cells of liver, and of the reticular tissue in general. That these cells are essentially phagocytic in function for practically all foreign material (disintegrating red blood cells, blood pigment, malarial pigment, carbon, foreign pigment, bacteria, protozoan parasites, disintegrating leucocytes, neoplasm cells, etc.) that may enter the circulation has been sufficiently demonstrated by the many observations in the literature of the last twenty-five years. Their hemolytic aspects, however, have been the ones most frequently observed and studied, and for this reason perhaps over-emphasized to the neglect of their other phagocytic functions. The earlier writings of Warthin and others upon pernicious anemia, the effects of splenectomy, hemolymph-nodes, etc., drew especial attention to the hemolytic rôle of the reticulo-endothelial system, and these observations have been confirmed by Pearce, Krumbhaar, Rous and others. Krumbhaar, in particular, has linked up the hemolytic function of the reticulo-endothelial cells with the normal hemopoietic functions of the bone marrow, and the fetal spleen and liver, and the pathologic myeloid transformations of spleen, liver and lymph-nodes into the comprehensive designation of "hemolytopoietic system." Neither the term nor the conception underlying it is a new one, and no new facts or observations have been added in recent years to the older ones

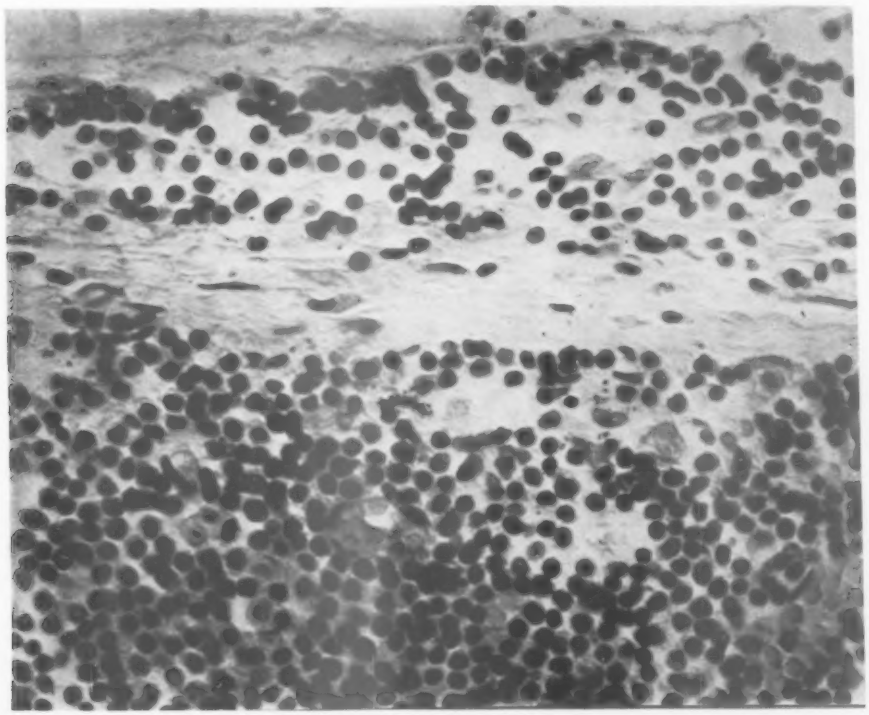

FIG. 2. Periphery of retroperitoneal node showing lymphosarcomatosis with infiltration of the pericapsular tissue. Chromatin granules in reticuloendothelial cells and scattered through the gland. Effects of irradiation. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length, 130 cm.

concerning the part which the reticulo-endothelial system plays in hemolysis and hemopoiesis. Without in any way minimizing the hemolytic function of this system it seems to the writers that there is in contemporary literature a tendency to magnify it to the position of a primary function of pigment-production and transformation, when in reality the actual facts so far controlled and accepted would seem to show that the hemolytic rôle of the reticulo-endothelial cells is only an incident of their broader and more essential scavenger function. In fact it has been demonstrated that the hemolytic function of this system, that of the cells of Kupffer in particular, may be inhibited entirely by an over-demand upon the primary scavenger function due to the presence of other material in the blood-stream stimulating their phagocytic activity. It is for this reason that the following observations of the marked degree of phagocytosis of nuclear material by the cells of this system may be of value in emphasizing the broader protective scavenger function of the reticulo-endothelium. It is also of value in so far as the effects of the new intensive deep-seated irradiation of human tissues are concerned.

The case of primary retroperitoneal lymphosarcoma in which this observation of extraordinary phagocytosis of nuclear material was made will be reported in detail elsewhere by Warthin, Crane and Jackson from the standpoint of the pigmentation of the skin; and it is Case 1 in the study of hepatic changes due to deep roentgen therapy by Case and Warthin[1] published in this Journal. It is, therefore, not necessary to repeat the details of the clinical history or general pathology. It is sufficient to say here that the patient was a male, aged thirty-seven, who for over four years had presented a very remarkable progressive pigmentation of the skin of great diagnostic interest to the many clinicians who saw him in consultation. Finally enlargement of the superficial lymph-nodes was noted, and biopsy showed

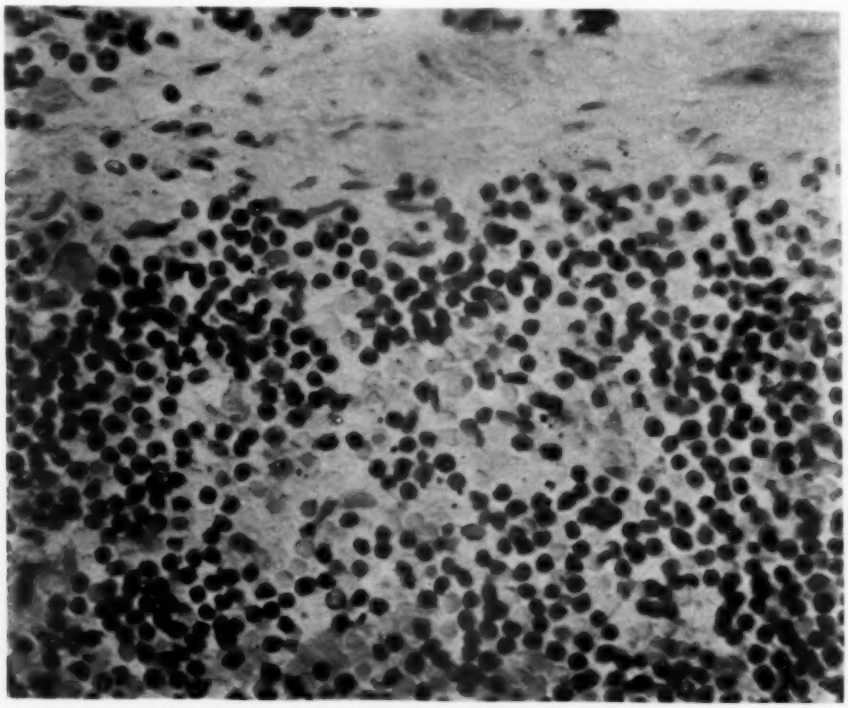

FIG. 3. Fragmentation of nuclei and necrosis of lymphoid cells in lymphosarcomatous node from retroperitoneal region, ten days after last roentgen treatment. Lymphoid cells show all stages of degeneration. Same magnification as preceding.

[1] CASE, J. T., and WARTHIN, A. S. The occurrence of hepatic lesions in patients treated by intensive deep roentgen irradiation. AM. J. ROENTGENOL. & RAD. THERAP., 1924, xii, 27.

that the patient had a generalized aleucemic lymphosarcomatosis. This fact led to the belief that the pigmentation of the skin was the result of the involvement of the solar plexus or adrenal region in tumor masses arising in the retroperitoneal lymph-nodes. On this conclusion the patient was referred to Dr. Case of Battle Creek, for intensive deep irradiation. From October 30 to November 12, 1922, he received ten treatments over the lymph-node areas, varying from 200 to 400 ma-min. through 1 mm. Cu and 1 mm. Al at 50 cm., with an effective voltage of 200,000. He showed a rather marked general reaction to this treatment which increased to such an extent that the irradiations were discontinued. Symptoms of pneumonia with pleuritis developed, and he died ten days after the last treatment.

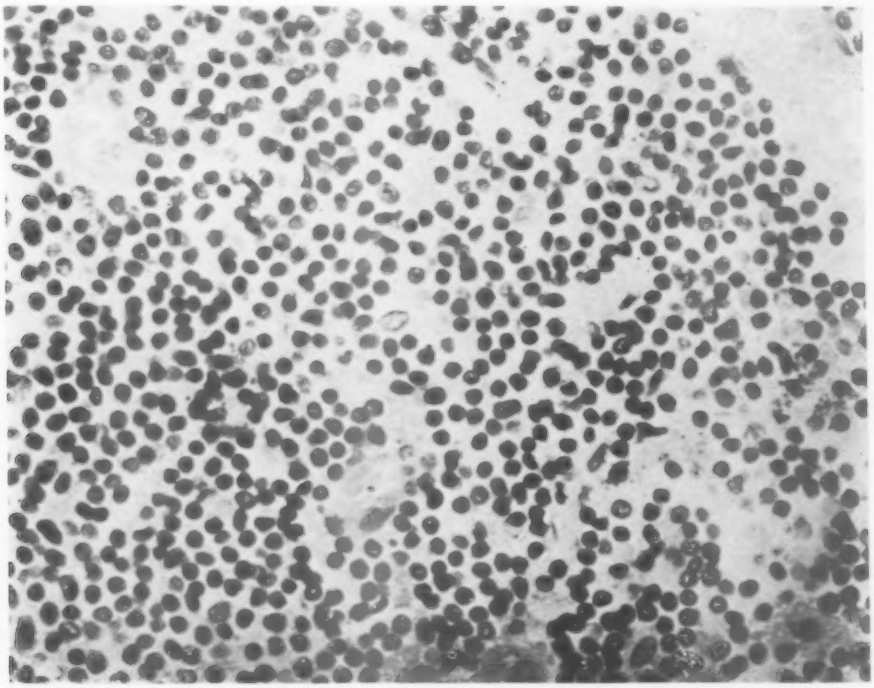

FIG. 4. Nuclear changes in lymphosarcomatous node ten days after last roentgen treatment. Chromatin fragments in reticulo-endothelial cells. All stages of nuclear disintegration. Same magnification as Figure 2.

The autopsy and microscopic study of the material showed a generalized lymphosarcomatosis, most marked in the retroperitoneal lymph-nodes, atrophy of solar plexus and adrenals, Addisonian pigmentation of the skin, necrotic hemorrhagic pneumonia with acute fibrinous pleuritis, areas of infarction in left cerebral hemisphere, arteriosclerosis, glomerulotubular nephritis, thymicolymphatic constitution, and marked changes in the lymphoid tissues and liver resulting from irradiation. For the details of these conditions the reader may refer to the other papers mentioned above. Here we wish to call attention to the marked effects of the intensive roentgen therapy upon the lympho-sarcomatous tissue of the lymph-nodes and the periportal lymphoid infiltrations of the liver with phagocytosis of nuclear material resulting from the disintegration of lymphoid cells.

The lymphoid tissues of the body presented a uniform atypical lymphoid hyperplasia replacing the normal lymph-node structure and infiltrating through the capsules of the nodes into the surrounding adipose tissue. The lymph sinuses were obliterated, no germinal centers remained, and there was no differentiation of cortical and medullary portions of the nodes; the atypical tissue consisted of cells of

lymphoid type enmeshed in a reticulum of delicate fibers in which numerous larger cells with paler larger nuclei (lymphoblasts) were scattered. The spleen, bone marrow and all of the primitive lymph-nodes of the body showed the same atypical lymphoid hyperplasia.

Throughout this atypical lymphoid tissue, especially in the peripheral, mesenteric and retroperitoneal lymph-nodes, and also in the hepatic infiltration abundant evidences of lymphocyte disintegration chromatin at all or only particles of it. These dead cells preserve their outline in many areas; in others the necrotic cells are condensed into an almost hyaline mass staining light pink with eosin. Through the living tissue (with nuclear chromatin staining), around and between the groups of dead cells, individual lymphoid cells in varying stages of nuclear disintegration are seen. Great numbers of mitotic figures are also present in the living tissue. Throughout the stroma phagocytic cells

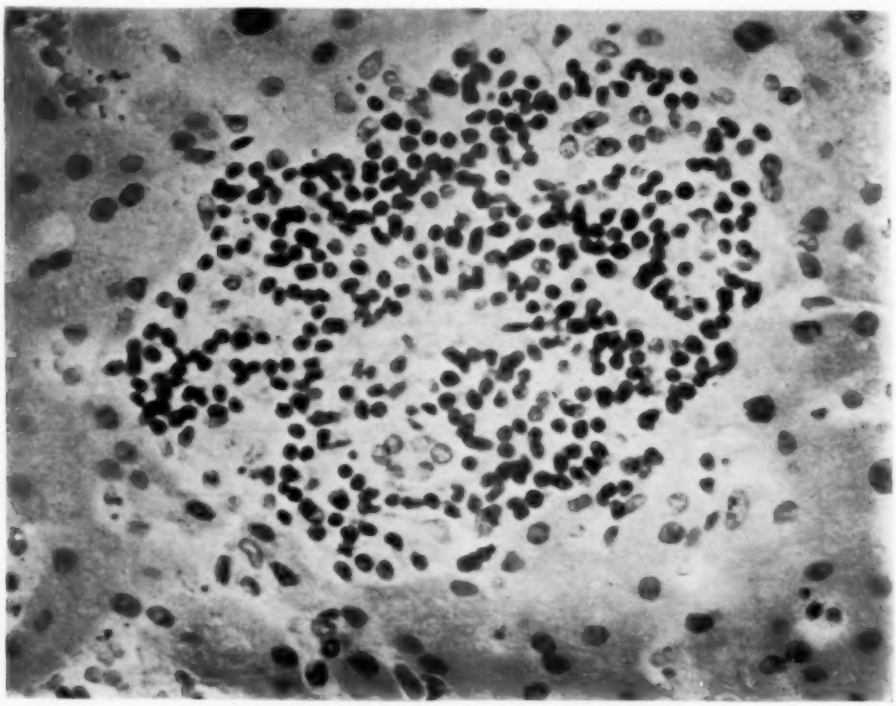

FIG. 5. Periportal infiltration from case of generalized lymphosarcoma after irradiation. Nuclear changes in lymphoid cells and in the epithelium of the small bile-ducts. In the neighboring liver capillaries the reticulo-endothelial cells show phagocytosis of chromatin fragments. Same magnification as Figure 2.

were present. These changes are identical with those produced by roentgen irradiation in the lymphoid tissues of animals and in the roentgen treatment of leucemia, lymphosarcoma and Hodgkin's disease in man as previously reported in the literature, differing only in intensity. These effects may be summed up, as follows:

Areas of simple necrosis of lymphoid cells are present throughout the lymphosarcomatous tissue (Fig. 1). These areas consist of hyaline or faintly granular masses of dead lymphoid cells showing no containing nuclear fragments and disintegrating lymphoid cells occur in great numbers, and wherever the reticulo-endothelial cells are plainly seen, as beneath and outside the capsular connective tissue, they present evidences of such phagocytosis. Around some of the necrotic cell masses multinucleated giant cells of the foreign body cell type are in process of formation from the reticular cells. In general the reticular cells appear larger than usual; some contain vacuoles in addition to chromatin particles; others contain granules

of hemosiderin and disintegrating red cells. The chromatin granules stain a deep blue, almost black in many of the phagocytes; in others and in the disintegrating lymphoid cells themselves there are all stages of loss of staining power in the nuclear fragments ranging from pycnosis and karyorrhexis to karyolysis. In many cells the chromatin seems to have lost its staining power from the center to the periphery of the nucleus, the latter showing as a ring of chromatin around the colorless central portion of the cytoplasm appears swollen, clear, as if hydropic, and often vacuolated. Agglutinated and fragmented red cells occur in the lumen of such capillaries.

The nuclear disintegration of lymphocytes is much less marked in the atypical lymphoid bone marrow than it is in the spleen, and is less marked in the latter than it is in the lymph-nodes. It is more marked in the mesenteric and retroperitoneal nodes than in the peripheral regional nodes. In the lymphoid infiltrations of the

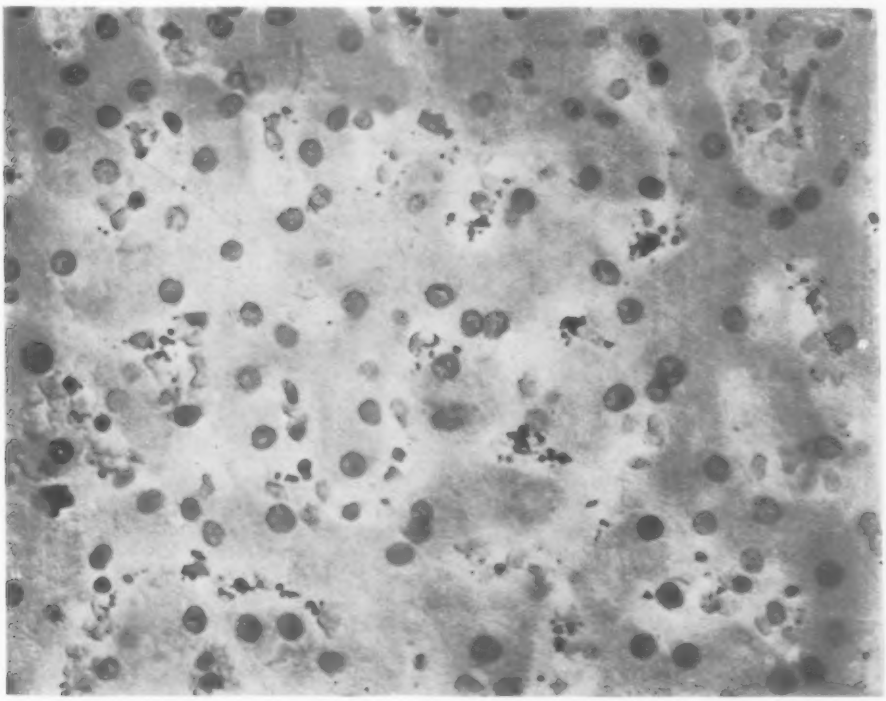

FIG. 6. Liver from case of generalized lymphosarcoma ten days after last roentgen treatment. Alcohol fixation, hematoxylin and eosin stain. Marked phagocytosis of nuclear chromatin and disintegrating lymphoid nuclei by Kupffer cells. Same magnification as Figure 2.

nucleus. In other cells the chromatin is reduced to a small central dark granule while the periphery is colorless. Ghosts of dead lymphoid cells occur throughout the nodes either singly, or in small or large groups. These nuclear changes are well shown in the higher power photomicrographs of Figures 2 and 3. The endothelial cells of the small vessels throughout the lymphosarcomatous tissue likewise show marked evidences of necrosis. The nuclei of the endothelial cells may show no chromatin staining at all, or the nuclei may be broken up into chromatin granules. The periportal connective tissue within the liver the effects of the irradiation are most marked in the lower thinner portions of right and left lobes, and on the anterior surface for a depth of 4 to 7 cm. In the thicker portions of the liver substance the destructive action upon the lymphoid tissue becomes less marked below this depth, and many deep areas of infiltration show no changes ascribable to the irradiation.

The nuclear changes in the lymphosarcomatous tissue are in no way different in kind from those that have been

repeatedly observed after irradiation. They differ only in degree from the effects of irradiation in cases of Hodgkin's disease, lymphosarcoma and leucemia observed by us before.

Much more striking, and far greater in this case than in any other we have ever seen, is the degree of phagocytosis of disintegrating lymphocytes and chromatin granules by the reticulo-endothelial system, particularly by the Kupffer cells of the liver. In the reticulum of the lymph-nodes, occur in any part of the cell body, but is more frequently seen in the neighborhood of the nuclei. The chromatin particles vary much in size, from apparently whole lymphocytes to fine chromatin dust. They stain blue with hematoxylin and the aniline basic stains, and red with carmine. With hematoxylin they stain deep blue-black as does the chromatin in pycnotic nuclei. The chromatin-nature of the granules is best shown in alcohol-fixed tissues. (See Figs. 5, 6, 7, and 8.)

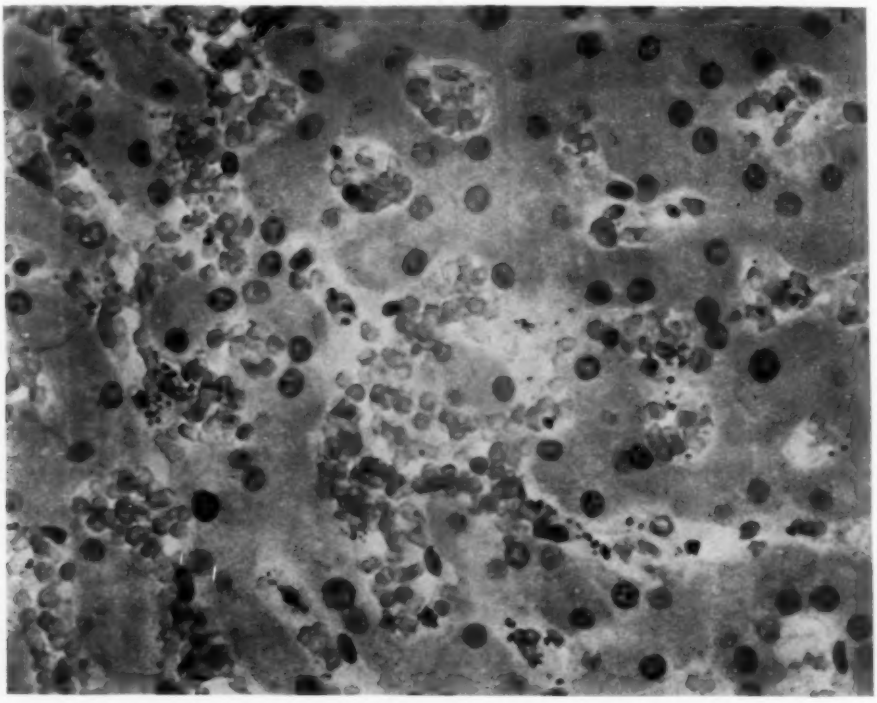

FIG. 7. Liver from case of generalized lymphosarcoma ten days after last roentgen treatment. Formol fixation. Hematoxylin and eosin stain. Phagocytosis of disintegrated nuclear material by Kupffer cells. Same magnification as Figure 2.

spleen, bone marrow, mesenteric and retroperitoneal adipose tissues, even in the peripheral lymph-nodes and subcutaneous tissue, but to a much less degree, the endothelial cells of the reticulum, lymph-spaces or blood-spaces appear as swollen phagocytes containing nuclear chromatin, as shown by its staining with nuclear dyes. The nuclei of the phagocytic endothelial cells stain well; the chromatin particles are scattered irregularly through the cytoplasm, sometimes showing definite clumping of the granules. This clumping may

Sections of the liver under low powers suggest at once the pigmentation of the Kupffer cells with malarial pigment, as seen in pernicious malaria. The fragmented chromatin has the same distribution throughout the liver lobules. That it is not pigment is shown by the staining. Likewise the possibility of a phagocytosis of melanin transported from the overloaded chromatophores in the skin is excluded for the same reason. This case did show a transportation of melanin to the peripheral lymph-nodes (cubital, axil-

lary and inguinal), but the transported pigment gives no coloration with nuclear stains, it remains brownish-black with all stains; and no evidences of the entrance of the cutaneous pigment into the general circulation could be found.

The findings in this case show a flooding of the circulation with disintegrating nuclear chromatin, apparently arising from lymphoid cells of the neoplastic nodes, as the result of intensive deep-seated irradiation. While in the capillaries of the liver

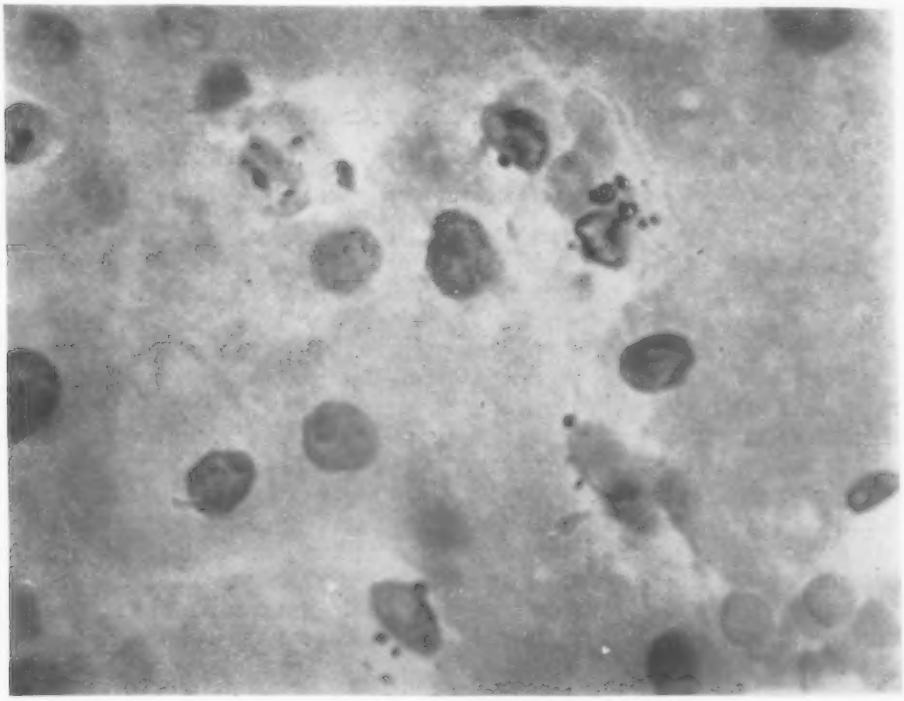

FIG. 8. High power view of Kupffer cells showing phagocytosis of disintegrating lymphoid cells after roentgen treatment. Photomicrograph, B. and L. oil-immersion, 2 mm.; compensating ocular, No. 4; bellows length, 85 cm.

some disintegrating nuclei appear to be free in the blood-stream, it is probable that this appearance is due to the sectioning, as with few exceptions the pigment granules are within the endothelial cells. Since the patient had a leucopenia (3000) before and after the irradiation, the great numbers of disintegrating lymphocytes seen here could not have been injured in the circulating blood, but the damaged cells and fragmenting nuclei must have been set free into the blood-stream from the lymph-node tumors after the irradiation. This case is of importance in demonstrating to what a marked degree nuclear disintegration and transportation of the products of such disintegration may occur after irradiation of the lymph-node tumors in aleucemic lymphosarcoma.

CONCLUSIONS

The new intensive deep-seated irradiation of the lymph-node tumors in a case of generalized lymphosarcoma in a patient dying ten days after the last treatment resulted in marked degeneration and necrosis of the atypical lymphoid tissue of the neoplastic nodes, with a flooding of the circulation with the products of such nuclear destruction, and the phagocytosis of the chromatin detritus in the circulation by the reticulo-endothelial cells of the body, especially the Kupffer cells of the liver. This phagocytosis of nuclear material was as marked as the phagocytosis of blood pigment by these cells in severe hemolytic conditions.

The primary function of the reticulo-endothelial apparatus is to remove formed material (blood pigment, extraneous pigment, nuclear and cellular débris, bacteria, etc.) from the circulation. In cases of marked leucocytolysis or lymphocytolysis they phagocytize the nuclear fragments just as they do the red blood cell detritus in hemolysis. They are primarily scavengers of the circulation, even though this function of intracellular digestion may serve a purpose in the working-over of food-substances or of such specific substances as hemoglobin. Their primary function is primarily a protective one.

In the intensive treatment of leucemia, aleucemic or leucemic lymphosarcomas, large amounts of the products of nuclear destruction are set free into the circulation. What relation this bears to the toxic condition developing after such irradiation remains to be determined.

FURTHER STUDIES OF IONIZATION MEASUREMENTS OF ROENTGEN-RAY INTENSITY

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IN our preliminary report,[1] we attempted to show the necessity of a standard position for the ionization chamber in a phantom of water for the purpose of determining the 100 per cent roentgen-ray intensity, which is intended to represent the intensity falling on the skin during a process of treatment by roentgen radiation. We brought out the fact that the measured roentgen-ray intensity, as ascertained by a horn ionization chamber, is different depending on whether the ionization chamber is placed on the surface of the water, half-submerged, or fully submerged in a water phantom. Since roentgen-ray intensity at any given depth is expressed by the ratio of the measured roentgen-ray intensity at, say, 10 cm. depth in the water to the measured intensity on the surface of the water, it is important that we obtain a value representing the correct intensity on the surface. So it is seen that the percentage of roentgen-ray penetration will vary at various depths in the water phantom in different investigations unless all investigators follow a given set of standards.

The conditions under which roentgen rays are produced and measurements are made are as follows: The roentgen-ray tube is mounted in a cylindrical tube-holder surrounded by $\frac{1}{4}$ in. of lead, with a hole 10 cm. in diameter in the bottom to allow the radiation to escape. The filter is fitted in this hole and is located at a distance of 30 cm. from the target of the roentgen-ray tube. A water phantom is placed underneath the hole in the tube-holder. The surface of the water is 50 cm. from the target of the tube. Measurements are made by a modified Friedrich-Kroenig horn ionization chamber connected to an electroscope by an insulated wire through a flexible metallic tube, as previously described.[2] The cylindrical horn ionization chamber 1.5 cm. long and 0.8 cm. in diameter (inside measurements) is placed half-submerged in the water 15 cm. from the sides of the water phantom.

The water phantom used was constructed of aluminum with $\frac{3}{4}$ in. pure rubber vulcanized inside the rectangular aluminum phantom, 61 cm. long × 36 cm. wide × 31 cm. deep. The $\frac{3}{4}$ in. rubber and aluminum water phantom insures against an increasing quantity of roentgen-radiation scattered from the bottom of the water phantom made from a metal of rather high atomic weight, as the ionization chamber is lowered in the water for depth measurements of roentgen-ray intensity.

Figure 1 shows a schematic diagram of the electroscopic ionization system. Figure 2(B) shows the portion of the ionization

[1] WEATHERWAX, J. L., and LEDDY, E. T. Standardization of ionization measurements of intensity and measurements of scattered and secondary *x*-rays effective in producing an erythema. AM. J. ROENTGENOL. & RAD. THERAP., 1923, x, 488–493.

[2] Loc. cit.

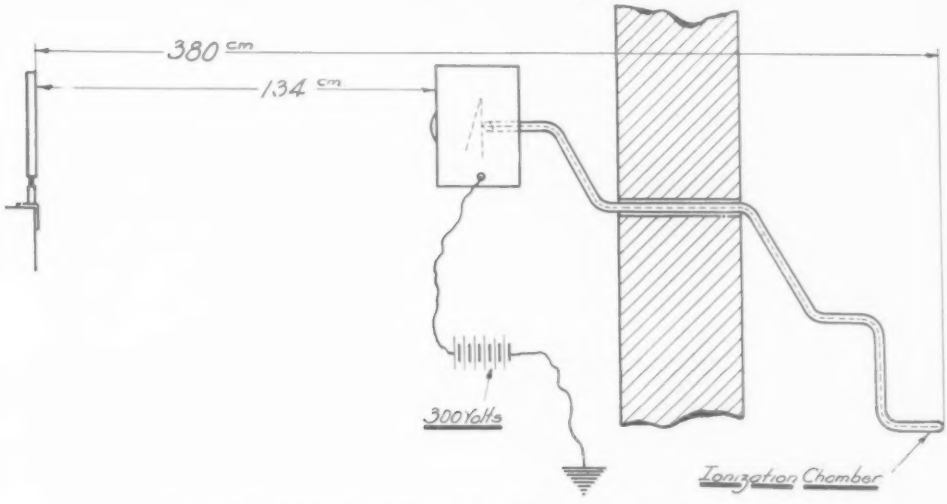

FIG. 1. Schematic diagram of the electroscopic ionization system.

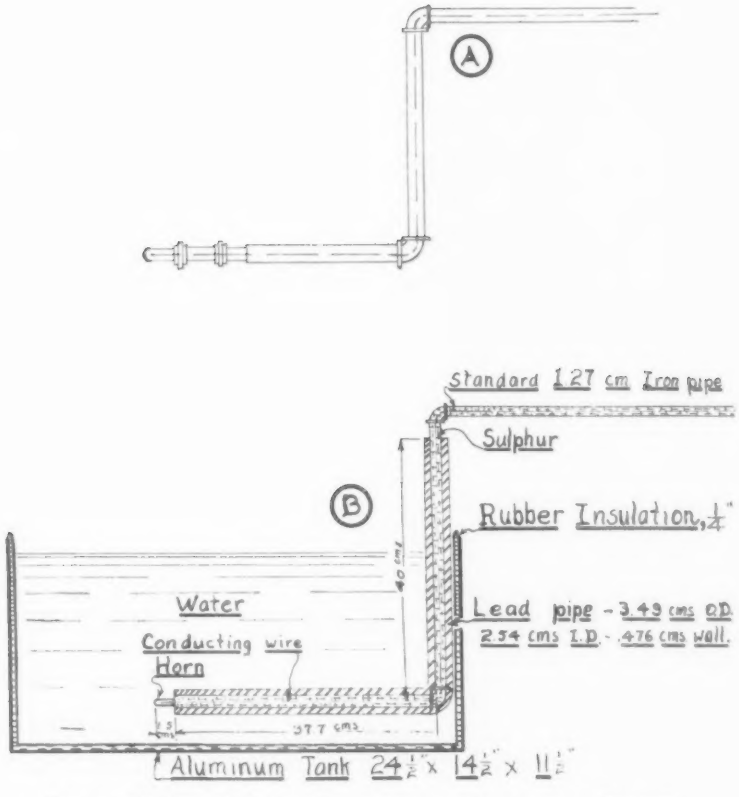

FIG. 2. Portion of ionization system entering water phantom.

system which enters the water phantom, the end marked "horn" representing the ionization chamber where the roentgen-ray intensity is being measured, the remainder being a part of the insulated conducting wire encased in lead ¼ in. thick. Figure 3 shows the ionization chamber and a part of the insulated conducting wire encased in a lead pipe mounted underneath the tube-holder. Figure 4 shows a room opposite the room containing the roentgen-ray tube, which contains the

FIG. 3. Location of ionization chamber.

FIG. 4. Electroscope and screen.

electroscope and scale for making measurements. This room is separated from the room containing the roentgen-ray tube by an 18-in. brick and concrete wall plus ⅛ in. lead. The insulated conducting wire is seen going through the wall to the horn ionization chamber, as observed in Figure 3. The electroscope is encased in a wooden box lined with lead connected to a ground wire. Sulphuric acid is placed in the box to absorb the moisture and provide dry air about the electroscope. The image of the leaf is observed on the ground glass screen. A motor-generator produces the voltage and we are able to get a maximum voltage of 550 volts. Connections are made from the motor-generator through a 12,000 ohm resistance with rack and pinion adjustment, and the voltage to the electroscope is taken off the resistance by potentiometer connections. The rack and pinion arrangement provides an adjustment for placing, accurately and quickly, almost any charge up to 550 volts on the electroscopic ionization system.

When we wish to make measurements of roentgen-ray intensity, the mattress, as is seen in Figure 3, is removed and a water phantom is placed on the table. The table can be raised and lowered bringing the surface of the water at a given distance from the roentgen-ray target.

In order to facilitate the speed, as well as the accuracy of our work, we have built an apparatus for moving our ionization chamber accurately in three different directions and have attached this apparatus to the cylindrical tube-holder. We call this apparatus "a three-way control." A diagrammatic illustration of the apparatus attached to the tube-holder, or tank, is shown in Figure 5. Figure 6 shows the "three-way control." It is seen that the insulated conducting wire, encased in a

lead tube leading from the ionization chamber, is held in a clamp at the bottom of the apparatus. It is also seen that the ionization chamber can be moved about by the operator at a distance, thereby facilitating the rapidity with which measurements can be made, as the machine does not need to be stopped to change the position of the ionization chamber. The apparatus is constructed so that it is possible to obtain an accuracy of $\frac{1}{50}$ of a millimeter. This means that we are certain as to the position of our ionization chamber at any time. Many readings can be made in a comparatively short period, and we can easily explore the field of radiation in the phantom of water in three directions.

The "three-way control" is mounted on a track, as shown in Figures 5 and 6, enabling one to move the ionization system to one side while treatments are in progress. When it is desired to make measurements, the ionization system is moved back under the hole in the tube-holder, centered and then by the "three-way control," the desired position can be rapidly obtained. The rapidity with which a set-up for measurements can be made after a patient has been removed from the roentgen-ray table is as follows: The mattress is removed, the water phantom placed on the table, the distance obtained from the target of the roentgen-ray tube to the surface of the water, and the ionization chamber put in position for measurements in less than three minutes.

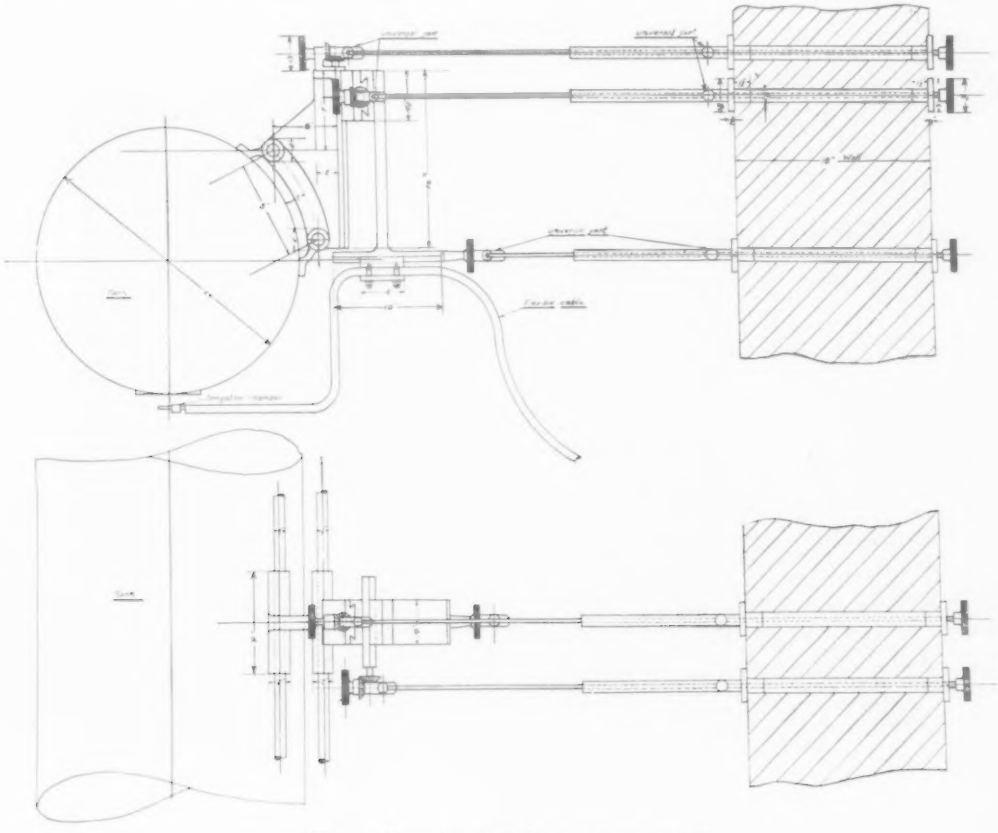

FIG. 5. Drawing of "three way control."

The time for the natural leak, or loss of charge from the electroscopic ionization system of 325 volts, during the winter months with the building heated, requires 125 hours. In the summer months the time for the natural leak, or loss of charge, is 35 hours. This difference is due to excess humidity.

Tests were made of the ionization system to determine the proportion of the loss

of charge placed on the electroscopic ionization system representing the ionization of the air in the small horn ionization chamber by the roentgen rays and the proportion of the loss of charge due to ionization by roentgen rays along the insulated conduction wire leading from the electroscope to the small horn ionization chamber. In other words, we wished to obtain the loss of charge on the ionization system due to ionization of the air in the small ionization chamber and wished to eliminate the loss of charge due to any outside factor. The loss of charge due to ionization of air along the conducting wire was determined by placing a lead cap over the horn ionization chamber to exclude the roentgen rays, and then operating the roentgen-ray tube under the same conditions used for making measurements. It was found that the portion of the conducting wire surrounded by sulphur encased in a gas pipe (Fig. 2(A)), was not protected sufficiently to exclude the roentgen rays. As the small horn ionization chamber, protected by a lead cap, was lowered into the water the loss of charge along the conducting wire was greater than on the surface of the water. A lead shield, as shown by Figure 2(B), was placed over the gas piping, and the loss of charge along the conducting wire was found to be eliminated and equal to the natural loss of charge when the roentgen-ray tube was not in operation.

The rectangular box attached to the tube-holder at the opening (Fig. 5), is an ionization chamber connected to a galvanometer, to measure the constancy of the roentgen radiation after passing through the filter. All our penetration measurements were made by observing the constancy of the roentgen radiation as well as by observing the voltmeter and milliamperemeter.

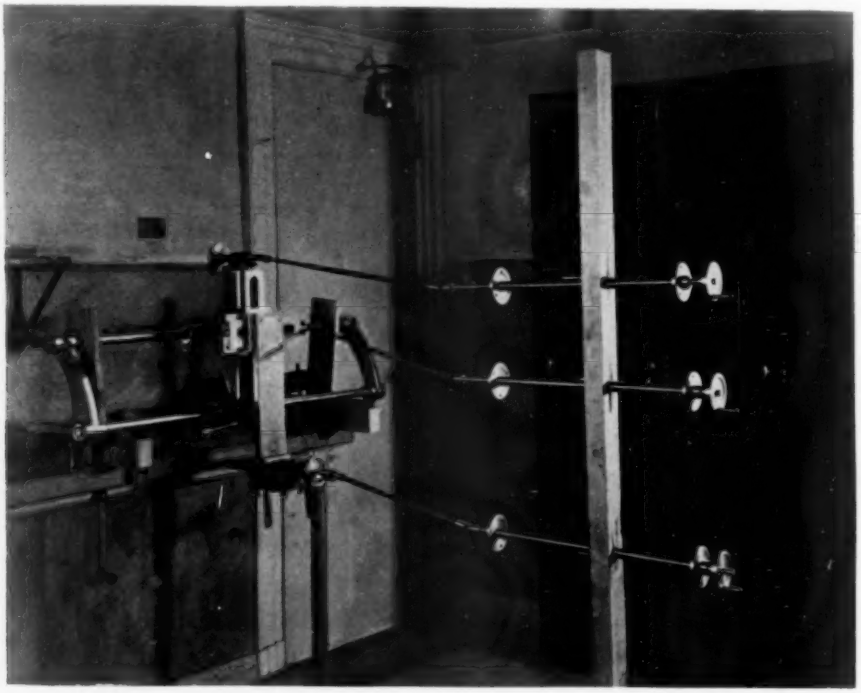

FIG. 6. Photograph of "three way control."

A test was made of our small horn ionization chamber to determine whether the voltage used gave us a saturated ionization current. During a roentgen-ray intensity measurement, there was a loss of charge from 325 volts to 300 volts due to the ionization caused by the roentgen rays bombarding the air atoms inside the small horn ionization chamber. A quantity of

radium emanation was placed over the small horn ionization chamber and measurements taken of the loss of charge from 325 to 300 volts caused by ionization of the air by radium rays. Increasing quantities of radium emanation were used until we obtained a greater ionization source than our roentgen-ray source. All our measurements gave us a value for the ionization current per millicurie agreeing to within 1.5 per cent. Since the agreement of the ionization current per millicurie was within experimental error, we were dealing with a saturated current.

Measurements were made with a horn ionization chamber half-submerged in a phantom of water, the surface of the water being 50 cm. from the roentgen-ray target. We pointed out in another paper that it required 23 mm. of aluminum to give the same intensity of roentgen rays as 1 mm. of copper when measured with the ionization chamber in close proximity to the filters. With the horn ionization chamber 20 cm. from the filters, half-submerged in water, it required 16.1 mm. of aluminum to give us the same intensity of roentgen rays as obtained with 1 mm. of

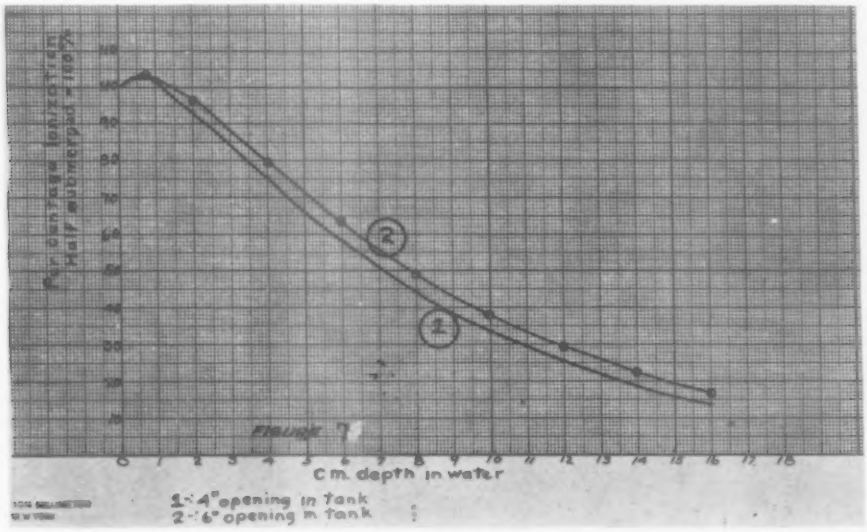

FIG. 7. Curves showing relation between the percentages of roentgen ray and centimeter depth in a phantom of water.

Investigations were made according to Duane's[1] curve showing the relation between the absorption of different wave-lengths of roentgen rays by aluminum as compared with a copper filter 1 mm. thick in determining the effective wave-length produced by the roentgen-ray machine. The intensity of roentgen rays produced by 200,000 volts, 4 ma., 50 cm. from the target to the center of the ionization chamber with 1 mm. of copper as a filter was measured. The copper was removed and various thicknesses of aluminum were used as filters and the intensities measured, the same conditions being maintained throughout except for a change of filters. copper as a filter. From Duane's curves, we obtained a value of 0.165 Ångstrom units as the effective wave-length.

Two curves are shown in Figure 7, giving the penetration of roentgen rays according to the set-up as described. The ordinates are percentages of roentgen-ray intensity at various depths as compared with the roentgen-ray intensity as measured by the ionization chamber half-submerged in a phantom of water. The abscissas are distances from the surface of the water to the center line of the horn ionization chamber which is in line with the electrode.

The following table gives the position of the ionization chamber in a phantom of water with the corresponding percentage

[1] DUANE, WILLIAM. Ionization methods of measuring *x*-ray dosage. AM. J. ROENTGENOL. & RAD. THERAP., 1923, x, 935–943.

of roentgen-ray intensity as compared to the surface roentgen-ray intensity in a circular field 16.6 cm. in diameter and a circular field 25 cm. in diameter. The ionization chamber was placed in the center of each field.

Position	16.6 cm. diameter field	25 cm. diameter field
Half submerged	100 per cent	100 per cent
2 cm.	93.3 per cent	95.9 per cent
4 cm.	75.2 per cent	79.4 per cent
6 cm.	58.1 per cent	63.6 per cent
8 cm.	44.7 per cent	49.0 per cent
10 cm.	33.5 per cent	37.7 per cent
12 cm.	25.4 per cent	29.4 per cent
14 cm.	18.6 per cent	22.0 per cent
16 cm.	13.7 per cent	16.5 per cent

It is seen that Curves 1 and 2, Figure 7, are practically parallel, but from Curve 2 it is seen that with a field of 25 cm. in diameter there is a greater intensity for a given depth in the water than is shown by Curve 1 for a field of 16.6 cm. in diameter. For a larger field, there is more scattered roentgen radiation reaching a given depth than with a field of small diameter. It is seen that these curves coincide at 100 per cent, or when the ionization chamber is half-submerged. This does not mean that the intensity on the surface of the water with 16.6 cm. diameter field is the same as with 25 cm. diameter field. It means that 100 per cent is chosen in each case as the value of the roentgen-ray intensity as measured by the ionization chamber half-submerged in water for both positions, as the ratio of the roentgen-ray intensity with a field 16.6 cm. in diameter to the roentgen-ray intensity 10 cm. below the surface of the water is 33.5 per cent, and the ratio of the roentgen-ray intensity with the ionization chamber half-submerged in a circular field 25 cm. in diameter to the roentgen-ray intensity 10 cm. below the surface of the water is 37.7 per cent.

It was found that the roentgen-ray intensity with the ionization chamber half-submerged in a circular field 25 cm. in diameter is 104.5 per cent of the roentgen-ray intensity of a circular field 16.6 cm. in diameter.

SUMMARY

1. It has been shown that in order to make true ionization measurements of the intensity of roentgen radiation, one must be certain that all extraneous ionization along the conducting wire from the electrode of the ionization chamber to the electroscope, as well as natural losses of charge from the electroscopic ionization system, is excluded.

2. It has been shown that 200,000 volts, 4 ma., 1 mm. copper filter, gives an effective roentgen-ray wave-length of 0.165 Angstromunits.

3. The penetration of roentgen rays in a water phantom is shown by intensity readings made directly underneath the target of the roentgen-ray tube in two circular fields, 16.6 cm. and 25 cm. in diameter. The water phantom was constructed of low atomic-weight substances.

4. Figure 7, Curves 1 and 2 show the necessity of describing in detail the set-up for determining the 100 per cent, or erythema value. It is seen that there is an increase in ionization as the ionization chamber passes through the first few millimeters of water, the maximum increase depending upon the size of the field of direct radiation. The point of our previous paper was to call attention to the variety of roentgen-ray intensity measurements obtained from the same data depending upon the intensity measurements chosen as 100 per cent. These small changes in roentgen-ray intensity near the surface of the water are not detected unless a small ionization chamber is used in making measurements.

In conclusion, we have tried to point out some of the tests necessary to make of any ionization system before true ionization measurements of roentgen-ray intensity at a given point can be obtained. Failure by various investigators in the past to observe these leakages accounts for the fact that we have so many different percentages of roentgen-ray intensity at a given depth in a water phantom with apparently the same conditions for producing the roentgen rays, such as voltage, distance, filter and field.

THE ROENTGEN RAY IN THE TREATMENT OF GIANT-CELL TUMORS*

BY R. E. HERENDEEN, M.D.

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THE object of this article, the first of a series dealing with the roentgen-ray treatment of bone tumors, is to record the changes noted in giant-cell tumors following treatment with the roentgen ray or radium, and to compare briefly, the value of these agents with the standard surgical methods of treatment.

For more than half a century this disease has been recognized as a distinct clinical entity. Although many observers had recognized a difference between cortical and medullary tumors, Nelaton stands out prominently as the first to write a comprehensive description of giant-cell tumors and to call attention to their comparatively benign behavior.

In spite of the fact that since that time the character of the disease has been more or less well known and the diagnosis can be established with a fair degree of accuracy by clinical, microscopic and roentgenographic examination, still it is not uncommon to see in the literature even today, reports of treatment by amputation or to hear from patients themselves that they have been advised by physicians to submit to an amputation as a life-saving measure. Bloodgood years ago, called attention to the fact that many of these cases can be cured by a simple curettage, and today this procedure stands as the accepted surgical method of treatment.

DIAGNOSIS

In only a fair percentage of cases can the diagnosis be made by clinical methods. As a rule a history of trauma is obtained; but the etiology of these tumors and the rôle played by trauma in their production are still undetermined. The patient may state that, following injury, a swelling was noted which slowly increased in size and was accompanied by pain and impairment of function. On palpation a feeling of tenderness is evoked and a peculiar crackling sensation may be elicited.

The location of these tumors is frequently in the ends of the long bones—the distal end of the femur, the proximal ends of the tibia and fibula, the distal end of the radius, and in the inferior maxilla; and they occur with greater frequency in early adult life. The roentgenogram reveals a symmetrical dilatation of the medullary cavity with a thinning out of the cortex of the bone, the tumor ending abruptly and showing but little attempt at extension down the marrow cavity. The striated and cyst-like appearance is so common as to suggest at once the nature of the process. As a rule, the tumor remains limited by a thin capsule of bone which is laid down in advance of the tumor as a result of the tension placed on the periosteum.

Incision into the tumor discloses the presence of a currant-jelly-like mass. When a microscopic examination is made the characteristic giant cells, forming its bulk and from which the name of the tumor is derived, are seen.

CHARACTER AND COURSE OF THE DISEASE

If left untreated, the tumor slowly increases in size, perforating the bony capsule at points, extending through the epiphysis and sometimes breaking into a joint, and its consistency becoming soft and spongy. Spontaneous fractures occur usually, with but little attempt at bone-production. The growth, however, remains localized, and no evidence of distant metastasis occurs. However, a case has been reported by Stone and Ewing, in which a giant-cell tumor became transformed, after repeated curettements for recurrence and infection, into a malignant metastasizing tumor, which caused the death of the patient. Numerous other cases have been reported in which the tumor recurred locally after curettement or excision, and even in the stump or regional tissue after amputation.

The early history of the treatment of this disease was one of amputation, later,

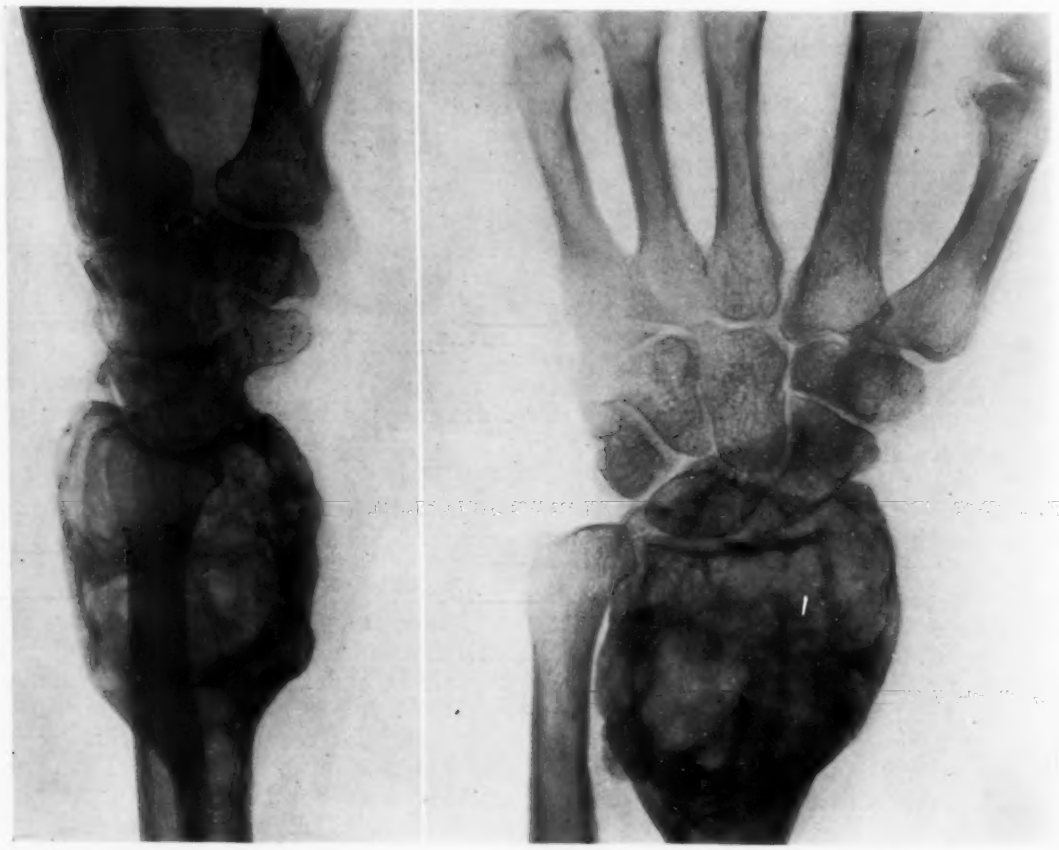
* Read at the Fifth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 24–26, 1924.

resection or simple curettement was performed. In a recent paper, Codman says that there will be found occasions when amputation is the wisest course; but he mentions also the value of the roentgen ray in treatment. At the Memorial Hospital, during the past few years, an attempt has been made to treat a number of these cases with the roentgen ray or radium alone, and the material studied in writing this paper consists in most of the giant-cell tumor cases admitted during the past five years.

They are grouped as follows: Group I consists of those cases in which no operation was performed. (In two or three instances incision for biopsy was done.) Group II consists of those cases referred for treatment on account of recurrence following operation; Group III consists of those cases referred for treatment to prevent recurrence after operation.

In the majority of the cases representing Group I, the roentgenographic features were so characteristic that the diagnosis was made without the aid of a biopsy. The changes observed, following treatment, were largely in those cases in which there had been no incision into the tumor.

It is realized that in this group of cases, called giant-cell tumors, there are important variations in structure and malignancy, in cases in which the roentgenogram resembles that of the typical giant-cell tumor of the epulis type. It may well be, that there are different clinical entities included in this group. In these instances one may gain the impression that a benign process is being dealt with, when, in reality, a tumor of malignant properties is present. Tumors belonging to the endothelioma group, and tumors in which spindle cells predominate, are examples.



CASE Ia. Showing beginning ossification of the tumor after the reaction subsides.

CASE 1*b*. Showing giant-cell tumor before roentgen-ray treatment.

CASE 1*c*. Showing the reaction to radiation.

CASE 11*a*. Showing giant-cell tumor, distal end of radius before curettage.

Variations occur also, but with benign properties, the recognition of which can only be obtained microscopically or by examination of the entire tumor. It may be well to state that it appears to be hazardous to place too much reliance upon a microscopical diagnosis based on a single small section obtained on incision of the tumor; and Ewing lays considerable emphasis on this point in a recent article.

rence and 5 to prevent a recurrence after curettage.

These figures emphasize two things: Of the cases of giant-cell tumor admitted to the hospital, about 15 per cent apply for treatment to prevent recurrence, on advice of their surgeons, who apparently realize the difficulty of removing all of the tumor tissue; about 20 per cent apply for treatment for a recurrence—some cases having

Case 11*b*. Showing recurrence after curettage.

Case 11*c*. Showing reaction to radiation.

These tumors may frequently contain areas of hyalin cartilage or cyst-like areas having the appearance of benign bone cysts or cystic osteitis fibrosa. Other tumors may be found to contain yellowish or grayish material, mostly of a firm consistency as compared to the jelly-like material of a giant-cell tumor, or to contain myxomatous material of lipoid substance.

In addition to the cases in Group 1, 7 cases were treated on account of a recur-

a recurrence after two or three curettements or attempt at local removal.

The remainder—and it is with these cases that this paper mostly deals—were treated with the roentgen ray or radium alone, and in only 2 cases incision was made for diagnosis, and this prior to coming to the hospital for treatment. It may be well to state here that in those cases where an operation had been performed, even to some extent in the cases where incision only for biopsy was done, the changes

following radiation, noted in Group 1, were absent or slight.

DESCRIPTION OF THE REACTION TO TREATMENT

Plates made from one to two months following treatment have revealed in almost every case, the same reaction, which consists in rapid enlargement of the tumor, with expansion of the cortex and a thinning out of the bony capsule of the tumor, until hardly any of the outline is visible. Prior to the demonstration of these changes in the roentgenogram the skin becomes reddened, and the parts swollen and soft or edematous to the touch. As time goes on the redness and swelling subside, the tumor becomes firm to the touch, and a roentgenogram then reveals a return of the outline of the tumor, with evidence of the production of bone or deposit of calcium in its capsule. The function of the part returns, pain disappears, and the tumor feels firm or stony-hard. A plate made later discloses increasing density and calcification, and later still the entire mass seems converted into almost solid bone.

During the stage of reaction—that is, a month or two after the first treatment is given—the tumor has all the appearance, both clinically and roentgenographically, of a rapid increase in growth. Most surgeons and others unfamiliar with the changes induced by the roentgen-ray treatment, assert that it is a failure, and the assertion is also made that it stimulates the activity of the growth, hence immediate operation is advised. If, however, at the end of another month or two, the patient is examined and a roentgenogram is made, it will be found that the reaction has subsided, that the tumor is becoming ossified, that pain is relieved and function is returning; and that there is present a well-marked effort at a healing-process cannot be ignored.

CASE 11*d*. Showing beginning of ossification after reaction has subsided.

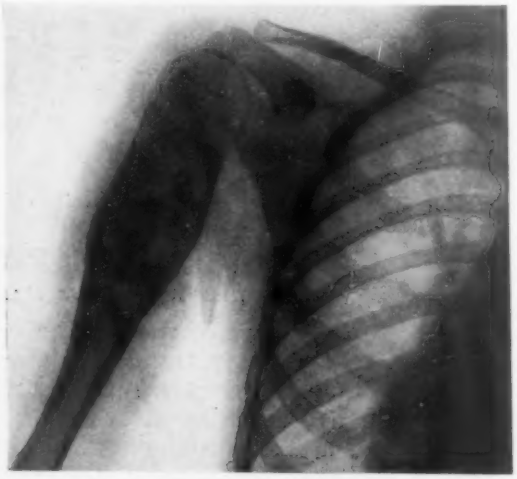
Up to the present time, 16 cases of primary giant-cell tumor of the bone have been treated at the Memorial Hospital with the roentgen ray or radium alone.

All of these cases were filed at Boston in the Registry for Bone Sarcomas. The oldest case was treated five and a half years ago, and is today apparently cured. Eight of the 36 cases studied were classified as atypical, undetermined, or as tumors simulating giant-cell tumors. And this figure emphasizes the frequency with which one encounters variations from the typical or characteristic giant-cell tumors.

CASE IIIa. Shows the tumor in the upper end of humerus at the time of curettage.

CASE IIIb. Shows the recurrence and condition at the time of radiation.

CASE IIIc. Shows the reaction to radiation.



CASE IIId. Shows calcification taking place after the reaction has subsided.

PROGNOSIS

From the study of all the cases and the course following treatment, it does not seem premature or too optimistic to say that it is believed that most of them can look forward to a complete cure and restoration of function. It may be that in some of the more advanced cases only a retardation or a halt in the growth with firm encapsulation and without dense ossification will result from the treatment; but if so, these cases will be in a much better position for curettage than they were prior to the radiation. And it does not appear unwise, before advising a patient to submit to an amputation on account of the size and location of the tumor, and the fact that it may have broken through into a joint, to give roentgen ray treatment a fair trial to obviate the loss of a limb by amputation.

CASE IVa. Shows giant-cell tumor in upper end of tibia prior to reaction.

TECHNIQUE

GROUP I. These cases have all been treated with external radiation by the roentgen ray or with the radium pack, and it is the impression of those who have followed these cases at the Memorial Hospital, that the use of the roentgen ray has given better results, all things considered, than the use of the radium pack.

It is further believed that the use of radium when buried in bone tumors or used in needle appliances may be easily followed by areas of necrosis and infection, which occurrence in the treatment of bone tumors constitutes a more serious and difficult problem to deal with than when following the treatment of tumors occurring in glands and soft tissues.

Both low and high voltage radiation has been employed, the selection depending on the size, location and depth of the tumor. Therefore, most of our cases were treated with the low voltage apparatus, exposures ranging from 15 to 25 minutes were given, 2 to 4 areas being radiated at 3 or 4 day intervals. A target skin-distance

CASE IVb. Shows expansion of tumor reaction to roentgen treatment.

CASE IVc. Shows tumor with beginning of ossification as reaction subsides.

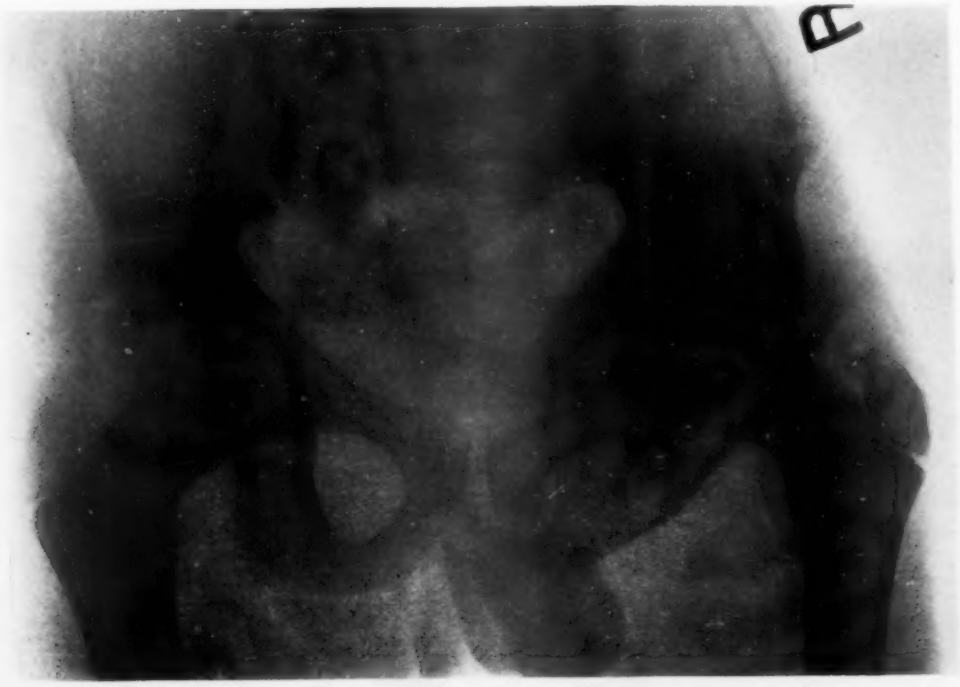
Case v*a*. Tumor of ischium when first treated by radiation in April, 1919.

of 12 to 15 in. is employed with 4 or 5 mm. Al filter; 4 or 5 ma., a 10-in. back-up spark, and 140 kv. are the factors present when the lower voltage apparatus is used. In the use of the high voltage apparatus, we have employed, as a rule, a target skin-distance of 50 cm. with an exposure of 60 to 80 minutes. From 1 to 3 treatments are given, depending on the case. A 0.5 mm. Cu filter is used with 4 ma. and 200 kv.

The above treatment results in an erythema which is seen from two to three weeks after exposure, and disappears, followed by a slight pigmentation.

In general, it seems advisable to employ a technique capable of obtaining the reaction described above, and the case when first seen should be treated heavily and energetically enough for this purpose.

The tumor may be slow in manifesting a reaction, which may vary in degree according to its histology, the dosage employed, the extent, location and rapidity of growth, and age of the patient.



Case v*b*. Shows dense ossification and decrease in size of the tumor in April, 1924, five years later.

The more superficial, well encapsulated, and rapidly growing the tumor is, especially when occurring in a young individual, the more well-marked and prompt will be the reaction. Occasionally, it may be necessary two or three months after the first treatment, to start another series.

Although the danger of over-radiation is not great, if the treatments are given as described above, it is possible, especially if the radium pack or high voltage machine is employed, to obtain after repeated exposures extending over many months, radiation-changes in the parts about the tumor, which may later give rise to the production of fibrous tissue, telangiectasis or ulceration of the skin, and even to osteitis, resulting in great pain which may only be relieved by morphine or may later necessitate amputation. One such case has occurred to my knowledge, where a giant-cell tumor was treated with radium by a surgeon, after a curettage to prevent recurrence of the tumor. The possibility of the changes occurring later, following repeated doses of radiation, were apparently overlooked. After a mid-thigh amputation was performed, which the patient insisted upon owing to the great pain, examination revealed no evidence of tumor; a clean cyst-like cavity was found and considerable osteitis was noted, but no evidence of definite calcification or bone production in or about the cavity was found. And in the series of cases in Group III treated after curettage to prevent a recurrence, no recurrence has been found to date, but on the other hand, a shell-like cavity persists and very little calcification or attempt at filling in of the tumor-cavity with new bone can be demonstrated in plates made many months, and in some instance, years, following the operation.

In Group II the cases were treated for recurrence following operation. The prompt relief from pain and the clearing up of an infection, with return of function have been notable features; but the reaction to radiation, as described above, has been, in some instances slight, and calcification of the tumor slow to take place. The recurrence of the tumor has often manifested itself in the scar of the incision made for the curettage. Such recurrences are less amenable to radiation and resist heavy doses. An incomplete operation is usually worse than none at all. It is easy to see from a study of the roentgenograms of some cases, how large parts of tumor tissue could be left behind, untouched by the curette and inaccessible to the caustic later applied.

SUMMARY

1. The appearance of the giant-cell tumor in the roentgenogram can usually be relied upon to establish a correct diagnosis.

2. Treatment by radiation obviates, in many cases, the loss of the limb by amputation.

3. Treatment by radiation can be relied upon to produce growth-restraint, firm encapsulation of the tumor, and relief of pain in the majority of cases.

4. A more rapid ossification is brought about, with a more rapid restoration of function than when some surgical procedure is the method of treatment.

5. Treatment by radiation is followed by a reaction evidenced clinically and roentgenologically, simulating rapid growth of the tumor. Pain and tenderness diminish as the reaction subsides, ossification takes place and function returns.

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RADIATION THERAPY IN TREATMENT OF LEUCEMIAS SUMMARIZED FROM A SERIES OF TWENTY-FIVE CASES

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THE 25 cases which form the basis of this communication are reviewed from our files more with the hope of summarizing our present results of treatment in the leucemias than with the desire of offering anything spectacular or new. It is hoped that this review may serve as a stimulus to improve the present methods of treatment or to devise better means of combating this apparently hopeless malady.

In 1834 Virchow and Bennett working independently first described this interesting group of diseases. In 1885 Ehrlich, by improved staining reactions, separated them into the lymphatic and the myelogenous groups. Since them comparatively little progress has been made except in the way of suggesting from time to time some empirical means of treatment.

The etiology still remains unknown and a definite classification from the pathological standpoint is far from accepted. Ewing in his monumental study on "Neoplastic Diseases" groups the leucemias with the lymphosarcomas, thus suggesting their resemblance to malignant processes; Mallory frankly views the leucemias as true malignancies of the hemopoietic system, while belief in infection as the immediate or remote cause is held by many able workers.

Histo-pathologic studies may not always reveal the true nature of this disease, as is shown in the reports on biopsy specimens in this series. Reports on glands so removed vary as follows: Myelogenous leucemia, lymphosarcoma, round-cell sarcoma, lymphoma, atypical Hodgkin's disease, malignant lymphoma, lymphatic leucemia. This by no means reflects on the ability of the pathologist but rather more strongly brings out the fact that these processes are closely related to, if not true malignant processes of the blood-forming organs, as seems to be the prevailing belief in this country today. It seems likely that the chloromas and erythremia rubra may also belong to this group of diseases.

Of these 25 cases, 16 fall into the lymphatic, and 9 into the myelogenous group.

As shown by Tables I and II, the disease proved to be more prevalent in males. This is in accord with the figures of 4 to 1 as usually given, the ratio being 4 to 1 in this short series.

As is well known the disease may appear at any age, the youngest case in this series as shown in Tables I and II being ten years and the oldest case sixty-eight years of age.

The average duration in this series in the lymphatic type was 1 year, 7 months and 3 weeks; in the myelogenous type 2 years, 3 months and 2½ weeks. The duration of the individual cases according to type is shown in Tables I and II and the data there given were compiled as accurately as possible from the history given by the patient or the relative, coupled with observation of the case until the record was closed. The findings are in accord with the general statement that the myelogenous type seems to be of longer duration and more chronic course besides being apparently more amenable to treatment.

The clinical symptoms are those usually given in descriptions of this disease. The most prominent are enlargement of the spleen, which occurred in many, adenopathies involving any or all chains of lymphatics, petechiae, purpura, anemia, hematemesis, hemoptysis, melena, edema, anasarca, dyspnea, dyspepsia, constipation, diarrhea, jaundice, nausea, vomiting, epistaxis, headache, vertigo, syncope, deafness, weakness, malaise, loss of weight, pain, etc. In 2 cases herpes zoster was noted as a complication which in each instance occurred in the lymphatic type. This complication has been described as one of the neurological syndromes which may occur in this disease.

The diagnosis was made in most cases by the characteristic blood picture. There are, however, cases in this series which during observation might have been wrongly

TABLE I

MYELOGENOUS LEUCEMIA

	Case No.	Age	Sex	Approximate Duration			Condition on Last Report	Treatment and Remarks
				Years	Months	Weeks		
1	5029	28	F	2	9	..	Died	*x*-ray, Rad., El. Benz.
2	5077	55	M	..	11	..	Died	*x*-ray, Ar. Benz.
3	5228	21	F	1	11	..	Died	*x*-ray, transf., Ar.
4	5300	50	M	3	3	..	Unknown	*x*-ray, Ar. Benz.
5	5426	23	M	2	1	..	Improved	Rad. El. Ar.
6	6450	36	M	3	..	2	Died	Radium pack
7	6691	23	M	2	1	..	Unknown	Did not return for treatment
8	7884	63	M	3	1	..	Died	Ar. Died 2 wks. after admission
9	8145	28	F	1	8	..	Under treatment	*X*-ray, Ar. Much improved. Radium pack
Averages..		36.3	66.6 M 33.3 F	2	3	2		

Ar., Arsenicals, as Fowler's Sol. Sod. Cacodylate. Neo-salvarsan, Thiarsol.
Benz., Benzol.
Rad. El., Radium element, i.e. 50 mgm. Brass capsule, 1 mm. lead, 164 layers gauze.
Rad. pack, Radium emanations used in pack. Filtration.
Transf., Transfusion, indirect method.
x-ray, 90 kv., 4 ma.; Al filter, 20 cm. target-distance.
X-ray, 198 kv., 8 ma., 0.5 Cu filter.

TABLE II

LYMPHATIC LEUCEMIA

	Case No.	Age	Sex	Approximate Duration			Condition on Last Report	Treatment and Remarks
				Years	Months	Weeks		
1	5206	17	M	..	10	2	Died	*x*-ray
2	5290	18	M	1	4	..	Died	*x*-ray and transfusion
3	5391	29	M	..	1	3	Died	Transfusion. Died 9 days after admission. (*Acute*)
4	5433	52	M	6	6	..	Died	*x*-ray, Rad. El. Ar.
5	5681	42	F	3	7	1	Died	*x*-ray, Rad. El. and Pack. Ar.
6	5749	56	M	3	1	..	Died	Transf. Rad. El. Ar. Hilus glands
7	5814	54	M	..	10	..	Died	*x*-ray, Rad. El. Ar.
8	5930	53	M	5	3	1	Improved	Radium Pack, Ar.
9	6508	63	M	1	..	..	Unknown	Not treated
10	6998	68	M	..	4	..	Unknown	Not treated, Herpes zoster
11	7185	10	M	..	1	2	Died	Rad. Pack, Ar. Died 3 days after admission
12	7458	29	F	1	6	..	Died	Died 6 days after admission. Hilus glands
13	7856	33	M	1	5	..	Died	*X*-ray, Transf.
14	7897	38	M	..	4	..	Died	Rad. Pack
15	8167	15	F	..	1	..	Died	*X*-ray, Rad. Pack, Ar.-Acute
16	8170	65	M	1	6	..	Under treatment	Herpes zoster, Rad. Pack, Ar.
Averages..		40.1	81.5 M 18.5 F	8	3			

diagnosed on account of the resemblance of the blood picture on one or two isolated examinations to a grave anemia. This is the so-called aleucemic type of many writers and is well illustrated by the following blood pictures from Case Nos. 7856 and and 5681.

	Feb. 9, 1923		Feb. 13, 1923	
	Hb.	22%	Hb.	15%
	R.B.C.	1,344,000	R.B.C.	1,184,000
Case No.	W.B.C.	1,200	W.B.C.	1,000
7856	Polys.	60%	Polys.	66%
	Lymph.	39	Trans.	3
	Monos.	1	Lymph.	29
			Monos.	1
	Sept. 30, 1918		Jan. 7, 1919	
	Hb.	80%	Hb.	72%
	R.B.C.	4,002,000	R.B.C.	3,232,000
Case No.	W.B.C.	6,000	W.B.C.	9,000
5681	Polys.	36%	Polys.	68%
	Lymph.	54	Lymph.	29
	Monos.	8	Monos.	2
	Baso.	2	Eosino.	1
	Nov. 22, 1920		March 14, 1922	
	Hb.	90%	Hb.	100%
	R.B.C.	4,800,000	R.B.C.	5,248,000
	W.B.C.	40,000	W.B.C.	9,000
	Polys.	9%	Polys.	66%
	S. Lymph.	86	S. Lymph.	28
	L. Lymph.	5	L. Lymph.	1
			Monos.	4
			Eosino.	1

The blood picture in conjunction with the splenic enlargement or the adenopathies has generally been enough to make certain the clinical diagnosis and differentiate from Hodgkin's disease, Banti's disease, or splenic anemia.

In this connection it is interesting to note the large proportion of patients who complained of respiratory difficulties at some time during the course of the disease. This may be due to a combination of leucemic infiltrations and anemia as was well illustrated in Case No. 8167 and Case No. 7458 which during life gave most characteristic evidence of enlargement of the tracheobronchial glands, i.e., paravertebral dullness, bronchial breath and voice sounds below the first dorsal vertebra, and a most characteristic D'Espine's sign in the sense as recently described by Morse.[2] At autopsy these cases presented massive involvement of this group of glands.

The basal metabolic rate was determined in Cases No. 5930 and No. 5749, both of the lymphatic type. Here the result agreed with those of Gunderson, i.e., plus 30 per cent and plus 20 per cent being the respective findings.

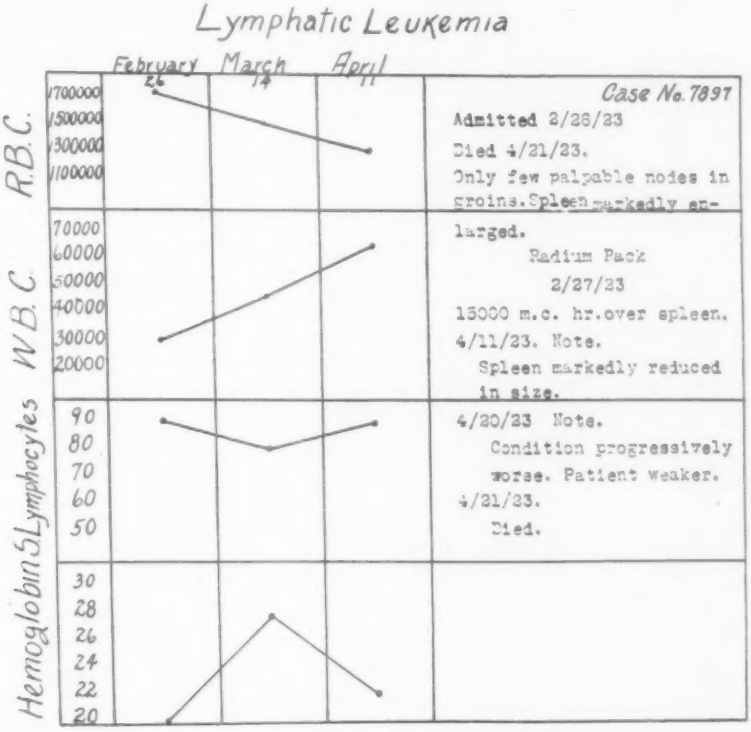
Graphs I, II, III and IV show representative blood curves during periods of treatment in Cases No. 7897, No. 7856, No. 6450 and No. 8145, respectively. Graph I represents a rapidly fatal type of lymphatic leucemia. As noted in the legend and notes the patient was given the radium pack with a dose of 15,000 mc-hr. over the spleen. There was a resulting marked reduction in size of the spleen but the patient grew progressively weaker and died, the disease being of four weeks' duration.

Graph II is made from the blood findings in Case No. 7856, of the lymphatic type. This was a more chronic case in which the total duration of the disease was 1 year and 5 months. This patient was transfused twice with marked improvement in the blood picture after each transfusion, especially after the first. Between the dates of transfusion, high power roentgen treatment was given which consisted of the following dosage: 30 cm. target-distance, 10 × 15 cm. field, 0.5 mm. Cu filtration, 198 kv., skin dose 23 and 30 per cent, 6 ma., depth dose 29 per cent. This treatment was given over the thighs, legs, sternum, and spleen, respectively. Here also the treatment appeared successful but the patient died a month and a half later. It might be argued that had the patient appeared for treatment earlier in the course of the disease, which had lasted over a year before coming to the Institute, the apparently good results might have been more lasting. Graph III depicts the more usual chronic and the apparently more responsive course in the myelogenous type. Patient No. 7450 appeared for treatment on November 4, 1920. He had had previous radiation treatment with the usual apparent symptomatic results which as usual, however, had been only temporary. At the time of admission the patient presented evidence of a skin burn from previous radiation therapy over the left hypochondriac region. On November 11, 1920, treatment by radium pack consisting of 9363.2 mc-hr. was given over the spleen. There was apparent symptomatic improvement after this treatment. The spleen which was

immense on admission was only slightly reduced by treatment.

Graph IV depicts the blood findings in a more hopeful type of case. This case, No. 8145, has responded so well that even the most pessimistic must feel encouraged. This patient has been caring for her home and baby except on the days of her treatments. This case again illustrates the more favorable course of the myelogenous type. It is in this type of case that radium and enlarged again, glands re-appeared, the leucocyte count arose, severe epistaxis supervened, and the patient died.

In this regard we agree with Neidhardt[3] who concludes: "There are not yet any stable therapeutic measures for treatment of acute leucemia. Yet it seems under prevalent conditions that it will be best to expect further results from roentgen-ray treatment and to pay special attention to proper dosage."



GRAPH 1.

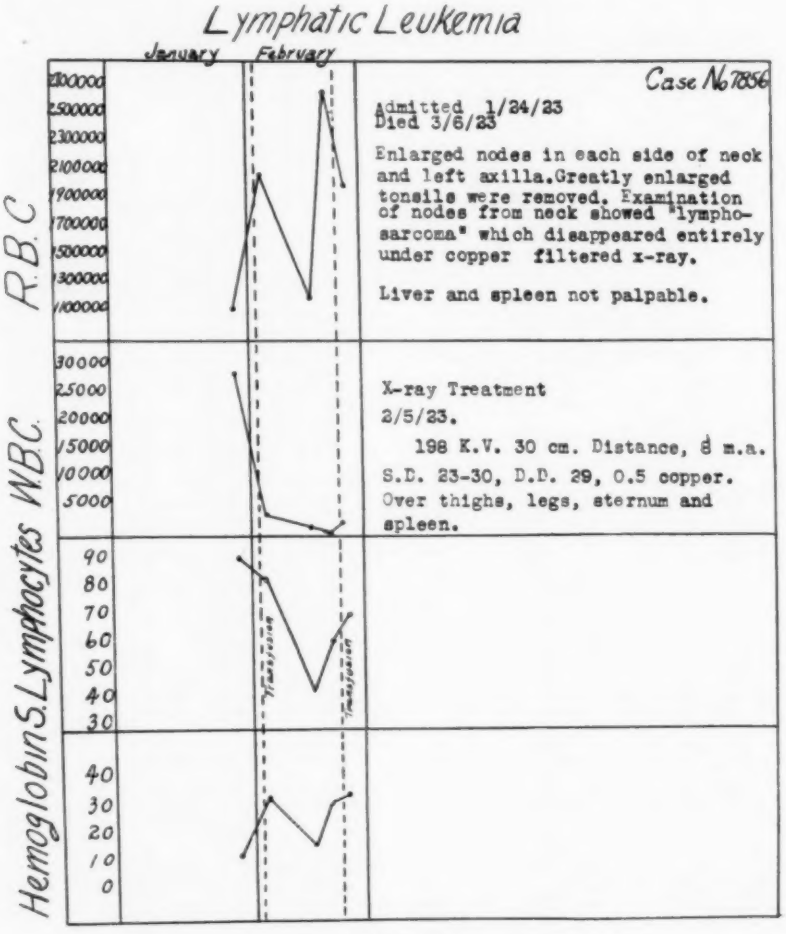
the roentgen ray have justly won credit but it is unfortunate that the results cannot be permanent.

In the series reported will be noted 2 cases of so-called acute leucemia. Both were of the lymphatic variety with the small lymphocyte predominating. Radiation was used in one case purely on an empirical basis, notwithstanding the usual injunction that this therapy is contraindicated in acute cases. The immediate response was remarkable, the patient apparently being restored to well-being from a moribund state in nineteen days. A week after, however, the symptoms recurred, the spleen

The various forms of treatment that have been in vogue have been tried with the exception of splenectomy, i.e., arsenicals, benzol, transfusion, radium, and the roentgen ray. These have been used in various combinations with the ultimate hope of arresting the progress of the disease, but on the whole the arrest or periods of remission have been only temporary at the best. Symptomatic response, however, has been noted after all forms of the above treatment and the same is in accord with our results. Splenectomy has not been attempted in these cases on account of the high mortality from this

operation and the poor risk for such radical procedures presented by the average patient with this disease when first seen by us.

Of all the above forms of therapy, it seems that the roentgen ray and radium are destined to hold a leading place in the treatment of this disease. This is due to the slightly different physical way. The cases in the first part of the series were treated with 90 kv., Kelly-Koett machine, 4 mm. Al filter, short target-distance; the spleen, adenopathies and long bones being the object of attack. Later with the acquirement of radium the pack was used over the same organs, giving 15,000 to 16,000


Lymphatic Leukemia
January
February
Case No 7856
Admitted 1/24/23
Died 3/6/23
Enlarged nodes in each side of neck and left axilla. Greatly enlarged tonsils were removed. Examination of nodes from neck showed "lympho-sarcoma" which disappeared entirely under copper filtered x-ray.
Liver and spleen not palpable.
X-ray Treatment
2/5/23.
198 K.V. 30 cm. Distance, 8 m.a.
S.D. 23-30, D.D. 29, 0.5 copper.
Over thighs, legs, sternum and spleen.
R.B.C
W.B.C.
S. Lymphocytes
Hemoglobin

GRAPH 2.

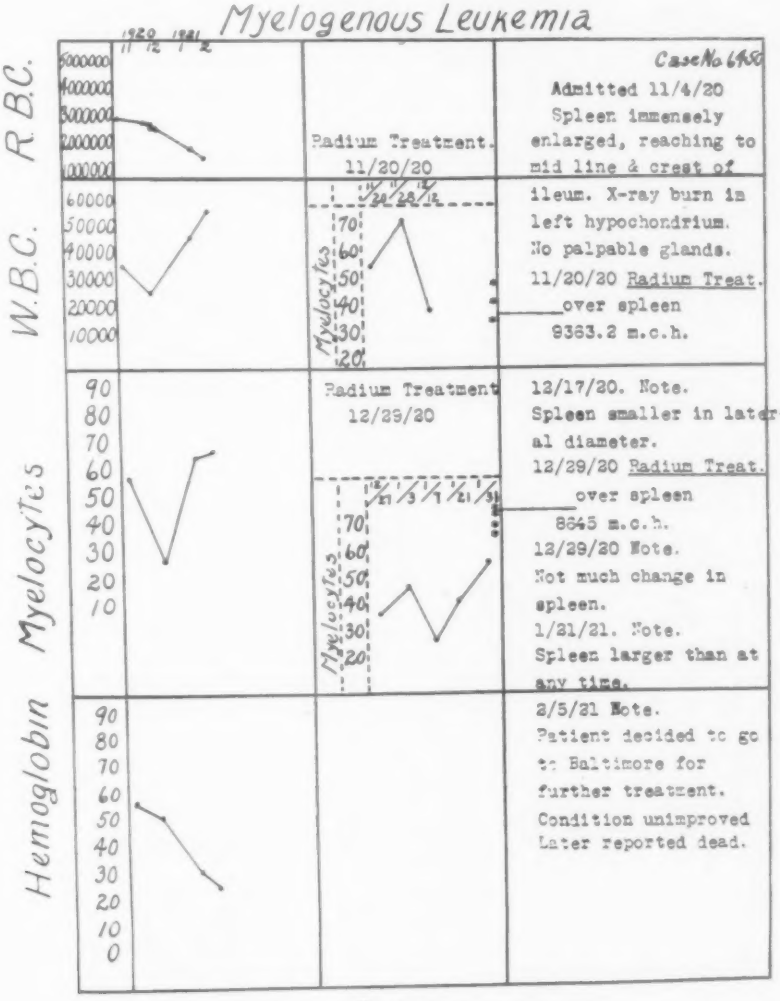
fact that a remission is often induced by these agents with the least degree of discomfort to the patient and in a short time. In our cases this therapy has been used alone or in conjunction with one or all of the above mentioned agents, as seems most suited to the improvement of the case.

We consider the deep roentgen-ray and radium treatment to be one and the same form of treatment administered in a mc-hr. filtered through 2 mm. brass and 1 mm. Al. In those cases treated with deep roentgen ray—200 kv. with copper filtration, long target-distance, and 8 ma.—the response has been equally encouraging.

We have not had any experience with the active deposit of radium intravenously as performed by Janeway. We have learned, however, that this case, very promising at first, after recovery from the severe initial reaction remained well with normal blood

for the period of a year, then was lost trace of for a while, and on ultimate search was reported dead. This form of therapy, although very heroic, does not seem much more encouraging in outlook than that used in the cases herein reported.

In the early cases of this series it was impossible to state the exact dosage be too low in the earlier cases and possibly a little high in the later series and it is just on this point that we all wish more illuminating knowledge and it is our earnest hope that an optimum dosage will ultimately be satisfactorily arrived at for treatment of this disease. While discussing the question of optimum dosage it might be well to


Myelogenous Leukemia
R.B.C.
W.B.C.
Myelocytes
Hemoglobin
Case No. 6450
Admitted 11/4/20
Spleen immensely enlarged, reaching to mid line & crest of ileum. X-ray burn in left hypochondrium. No palpable glands.
Radium Treatment. 11/20/20
11/20/20 Radium Treat. over spleen 9363.2 m.c.h.
Radium Treatment 12/29/20
12/17/20. Note. Spleen smaller in lateral diameter.
12/29/20 Radium Treat. over spleen 8645 m.c.h.
12/29/20 Note. Not much change in spleen.
1/21/21. Note. Spleen larger than at any time.
2/5/21 Note. Patient decided to go to Baltimore for further treatment. Condition unimproved Later reported dead.

GRAPH 3.

delivered to the leucemic tissues as at this time our apparatus was not standardized by accurate measurement. At present, with our improved radium pack[4] and deep roentgen-ray therapy plant which are constantly and accurately measured by a competent physicist, we can attempt to subject the leucemic tissues to definite dosage. On the whole, our dosage tended to quote from a recent German publication by Dreyfuss.[5] "The fairly good success attained in myelogenous leucemia stands out in contrast to the inferior results in the lymphatic type. These observations are in accord with those from other clinics. We use a dose of about 30 per cent in the spleen and glands.

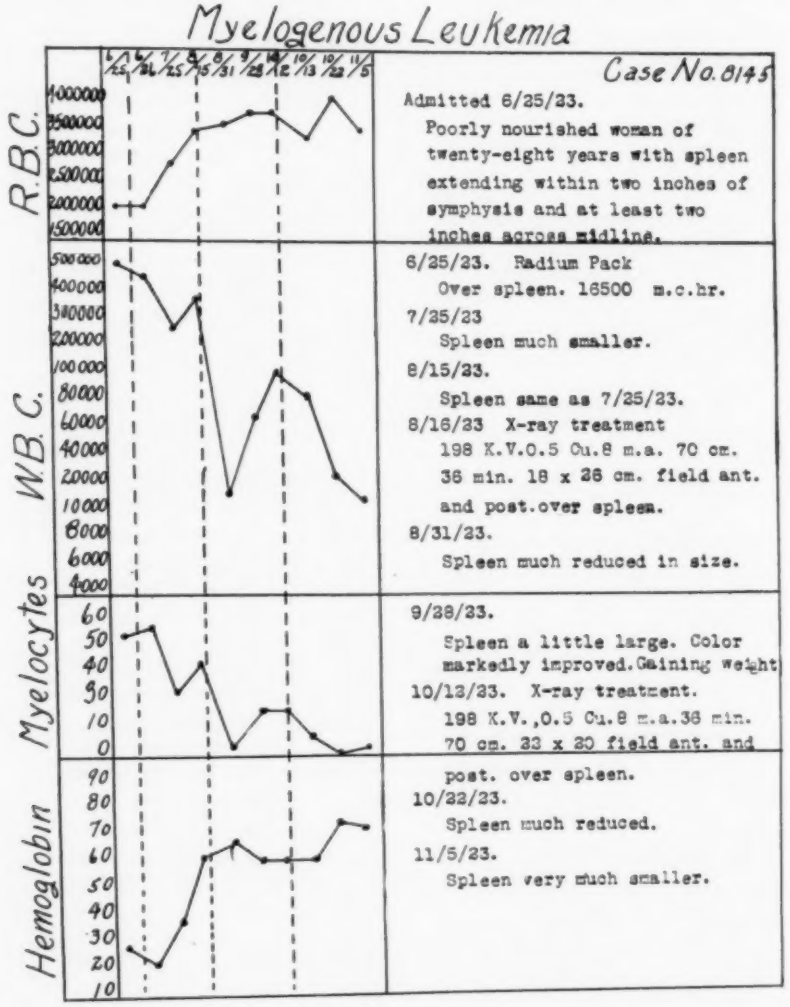
"The roentgen treatment is not an absolute cure either for the lymphatic or

myelogenous types but with the help of it we have succeeded, with careful treatment, in combination with internal therapy, in restoring a feeling of well-being for several years.

"The roentgen ray is, therefore, worth using in all cases of leucemia."

roentgen ray does not cure leucemia, but it improves the general condition, restores the earning capacity and has a favorable action on the erythrocytes."

The above conclusions are in accord with ours in this series of cases where low power roentgen ray, deep roentgen ray, and



GRAPH 4.

Recently Brant[6] reported 14 cases of chronic leucemia only one of which survived over thirty months, all being dead at the time of the report. He records the case of a woman who gave birth to a pair of healthy twins during the course of the disease. We had 2 patients each of whom gave birth to a healthy baby while under treatment. Brant sums up his estimate of roentgen therapy by stating that: "The

radium have all been used and we believe the following statement justified from our experiences:

While being very enthusiastic with the results of short-wave therapy in securing remissions with the least discomfort to the patient, we would lay stress on the fact that in our experience these remissions have not been permanent and the ultimate fate of the patients has been the same.

It is true, notwithstanding this gloomy prognosis, that in most cases of this disease so treated the sphere of usefulness has been extended and many have worked and enjoyed apparent good health till shortly before death.

SUMMARY

1. Twenty-five cases from the files of the New York State Institute for the Study of Malignant Disease are reviewed from the standpoint of radiation therapy.

2. Radiation therapy is empirical as is the case with benzol, arsenic, etc., but hastens remissions of disease in shorter periods of time and with less inconvenience to the patient than is the case with other methods. The other methods should be used as adjuvants when deemed necessary.

3. Radiation therapy should be used cautiously, if at all, in acute leucemias.

4. An optimum dosage is still to be desired in this form of therapy.

5. We have seen no cases of cure of this disease and know of no authentic cases of cure even with radiation therapy.

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RADIATION THERAPY IN FORTY-SIX CASES OF LYMPHOGRANULOMA (HODGKIN'S DISEASE)

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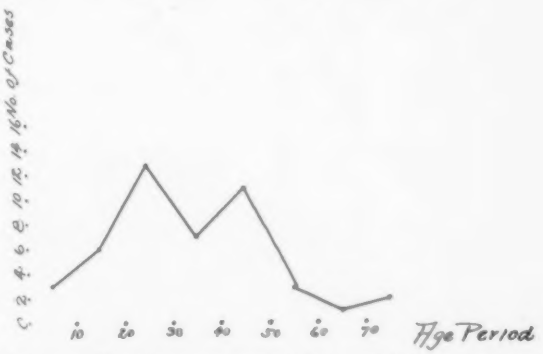
SINCE the discovery of this disease by Hodgkin in 1832, the cause has been vigorously sought with little actual success. It will be remembered that Sternberg believed this disease to be a form of tuberculosis. For a while this cause as an etiologic factor held sway. Then came the discovery of the "*Bacterium hodgkini*" of Bunting and Yates with the later evidence that this organism was probably a contaminating bacterium rather than the real cause. Since this time the relation of this disease to malignant processes has attracted attention until today many look upon this disease as closely related to tumor processes and probably partaking of the same unknown etiologic factors.[1]

Of the 46 cases herein reported (Table 1) 29 cases were in males and 17 in females. The usual stated proportion of males to females is 3:1.[2] In this series the proportion is 1.7:1. There seemed to be no relation to nativity or race. The incidence of the disease was greatest between the ages of 20 to 30, but all decades seemed to be affected. The oldest patient was seventy-three and the youngest five years of age. These facts are graphically illustrated in Graph 1 which is self-explanatory.



GRAPH 1. Showing greatest incidence of disease between the ages of 20 to 30. The oldest patient in the series was 73 and the youngest was 5 years of age. Average age, 33.68 years, when first seen.

In this series, the histories were negative for tuberculosis in the immediate relations

in all but 4 cases. Among these 4 patients, No. 7891 had one brother and one sister who died of tuberculosis, while patients No. 6326, No. 5981 and No. 5820 had one sister each who succumbed to the same disease. In 4, tuberculosis was found as a complication either during life or as a terminal manifestation discovered at autopsy, i.e., Case No. 7811 had a positive sputum; Case No. 6396 a complicating tuberculous

TABLE 1

SUMMARY OF FORTY-SIX CASES OF LYMPHOGRANULOMA

	Case No.	Sex	Age	Duration of Illness		Condition on Last Report	Treatment and Remarks
				Years	Months		
1	713	F	25	..	5	Died	*X*-ray
2	5016	F	54	5	..	Unknown	*x*-ray
3	5115	M	9	5	2	Died	*x*-ray, vaccine
4	5159	M	19	1	1	Died	*x*-ray. Autopsy
5	5201	F	5	..	3	Unimproved	Sympt.
6	5254	M	43	4	11	Died	*x*-ray, auto-gland. Rad. El.
7	5260	M	33	1	5	Died	Rad. El. Autopsy: mil. T. B. complication
8	5279	M	23	2	10	Died	Rad. El., *x*-ray, helio.
9	5310	M	29	13	..	Unknown	Untreated
10	5326	M	9	4	..	Improved	Rad. El. Ar.
11	5370	M	23	1	4	Improved	Rad. El., *x*-ray, Ar.
12	5388	F	18	3	7	Improved	Operation, *x*-ray, helio, myxedema as complication
13	5394	F	36	1	9	Unimproved	*x*-ray, helio
14	5401	F	48	2	8	Died	Ar. Rad. El., *x*-ray
15	5600	M	23	3	4	Unimproved	Rad. El.
16	5628	M	26	..	4	Unknown	Untreated
17	5754	M	49	..	7	Died	Rad. El. Died of pneumonia
18	5800	F	23	1	7	Died	Ar. *x*-ray. Autopsy
19	5820	F	53	..	5	Died	Rad. El., *x*-ray
20	5853	M	43	..	8	Died	*x*-ray
21	5915	F	13	1	2	Died	*x*-ray
22	5981	F	23	1	..	Unknown	Untreated; had previous *x*-ray treatment
23	6159	M	47	1	6	Died	*x*-ray
24	6216	F	29	4	6	Under treatment	Ar. Rad. Pack, *x*-ray, emetin
25	6309	M	45	..	11	Unknown	Untreated
26	6326	F	30	2	4	Improved	*x*-ray, Rad. El., Rad. Pack
27	6342	F	19	1	11	Died	*x*-ray, Rad. Pack, Ar., *X*-ray
28	6396	M	40	1	1	Died	*x*-ray
29	6613	M	18	11	5	Died	Rad. Pack, Ar., *X*-ray
30	6710	M	30	2	11	Under treatment	Rad. Pack
31	6716	M	39	3	11	Died	Rad. Pack, Ar., *X*-ray
32	6761	F	15	2	11	Improved	Rad. Pack
33	6816	M	24	1	6	Died	Rad. Pack, *X*-ray. Autopsy
34	7279	M	62	..	2	Died	Rad. Pack, Ar.
35	7363	M	31	1	..	Unknown	Untreated
36	7482	M	73	1	6	Died	*X*-ray. Improving but died of erysipelas
37	7553	M	51	1	11	Under treatment	*X*-ray, Ar., Emetin
38	7557	M	27	2	7	Died	*x*-ray, Emetin, Ar. Autopsy
39	7688	M	28	2	..	Unknown	Untreated
40	7745	F	41	1	6	Unknown	Emetin
41	7752	M	46	2	2	Died	*X*-ray, Rad. Pack, Emetin
42	7758	M	38	1	11	Died	Emetin, *X*-ray, Ar.
43	7811	M	29	5	1	Died	Emetin, Ar., *X*-ray, Positive T. B.
44	7891	F	71	1	3	Unimproved	*X*-ray
45	7941	M	41	1	8	Died	*X*-ray, Emetin, Ar.
46	8092	F	48	4	4	Under treatment	*X*-ray, Ar.
Aver	ages...	17F 29M	33.68	2	6.9		

Ar., Arsenicals, as Sod. Cacodylate, Salvarsan, Thiarsol, etc.
Emetin, Emetin-Bismuth-Iodide, emetin hydrochloride.
Rad. El., Radium element.
Rad. Pack, Radium Pack.
X-ray, Deep *x*-ray.
x-ray, Lower power *x*-ray.

apicitis; Case No. 5260 had miliary tuberculosis involving the liver and intestines, with fibroid tuberculosis of the lungs as demonstrated at autopsy. Case No. 7252 had tuberculous peritonitis with miliary tuberculosis. In these 2 latter cases the tuberculosis was probably a terminal manifestation of an old latent process.

In 2 cases only was there a history of malignant disease in the immediate relations, i.e., the mother of patient No. 7559 died of cancer; and the father and sister of patient No. 6326 succumbed to the same disease.

From the above it would seem that a history of either tuberculosis or malignancy was in no way a predisposing factor in the acquirement of Hodgkin's granuloma.

The stools were carefully examined in many cases after the manner of Kofoid[3] for amebae. To date, from our results, no conclusive assurance can be placed on amebae as a cause of this disease.

It has been stated that the diagnosis of this disease is always certain by biopsy specimens.[4] In our cases, biopsy or autopsy was performed in all, thus assuring the diagnosis of cases in this series. There are rarer forms of mediastinal and intestinal Hodgkin's disease where it may be impossible during the course of the disease to secure an externally enlarged gland for biopsy. These are the types of cases that prove difficult to diagnose and are generally diagnosed at time of exploratory operation or autopsy.

Lymphogranuloma often first manifests itself in a superficial chain of lymph glands. Thus the process began in the supraclavicular and cervical in 34 cases, cervical and axillary in 4, axillary in 4, mediastinal in 2, inguinal in 1, and mesenteric in 1. From the chain of initial involvement the process extended at varying rates of rapidity until the contiguous chains were involved, i.e., the mediastinal, parabronchial, mesenteric, retroperitoneal, etc.

One case, essentially mediastinal, showed at autopsy Hodgkin's nodules in the kidney and lung. This case had been treated for mediastinal involvement with immediate marked relief. This may throw some light on the extensiveness of these processes when first seen and the ultimate hopelessness of the present therapeutic attempts to cure this disease.

Another case was later diagnosed and operated upon for a complicating cholecystitis on the basis of a mass in the region of the gall-bladder, associated with fever, nausea and vomiting. At operation a a lympho-granulomatous mass was discovered in the upper right quadrant.

Another case developed a paraplegia from pressure of the mediastinal tumor on the dorsal cord. In this case the vertebrae were eroded and the tumor process had burst its capsule and become truly infiltrative.

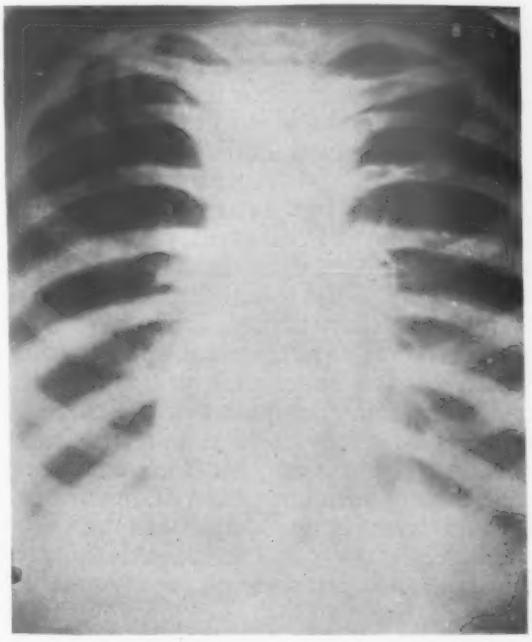


FIG. 1. Hodgkin's disease, showing involvement of mediastinum. Patient showed almost immediate response to deep therapy, which was, however, only transitory.

Many cases developed effusions into the pleural cavity. Two cases had typical chylous ascites.

Besides the adenopathies of the external glands, pruritis was noted in many cases as an early and intractable symptom. This condition sometimes antedates the adenitis as occurred in many of our cases. Night sweats were also frequent early complaints. Palpable splenic enlargement on the contrary was not so constantly observed as is

generally indicated in descriptions of this disease. It occurred in less than one-fourth of our cases.

Most cases had fever and malaise with loss of weight at some time in the course of the disease but especially as a late manifestation. There seemed to be no absolute type of fever curve predominating.

The blood counts were very interesting in that many showed a platelet count higher than 350,000. This, coupled with an increase in the neutrophiles of 10,000 to 30,000, an eosinophilia of moderate grade, and secondary anemia of varying severity should make one suspicious of this disease when any of the above symptoms are present. We did not observe the high transitional count described by Bunting[5] as common in the blood in this disease. In general, the blood findings in our cases agree with those recently reported in 18 cases of this disease studied by McAlpin.[6]

The physical findings at various stages of this disease were studied. Signs of adenopathy of the tracheobronchial glands were often elicited, i.e., D'Espine's sign, paravertebral or parasternal dullness, dilatation of the superficial veins over the chest anteriorly or posteriorly, increased voice and breath sound conduction below the first dorsal vertebra. Two cases presented massive enlargement of one or both breasts from lymphedema due to gland pressure. Many cases presented signs of effusion and pressure on the bronchial tree. Parenchymatous lung involvement was diagnosed in some but the signs as a rule were very indefinite. A careful history and roentgen examination of the chest often helped to interpret correctly otherwise vague and confusing physical signs. The liver was palpated in a considerable number of cases, in some cases even without accompanying splenic enlargement.

Diagnosis was generally easy after biopsy but before the results of this procedure tuberculous adenitis, leucemia and malignancies, especially lymphosarcoma, had to be considered. The leucemias are generally ruled out by the blood picture except in the aleucemic cases. Banti's disease or splenic anemia may have to be differentiated, even in fact an aplastic pernicious anemia.

Practically all cases during the course of treatment received roentgen-ray or radium treatment. Here the attempt was made in most instances to put from 60–70 per cent of the human erythema dose into the lympho-granulomatous tissue. In many cases the immediate response was remarkable. One case was admitted with severe dyspnea which was almost proving fatal from mediastinal pressure. The patient submitted to treatment only under the greatest respiratory embarrassment, and needed to be carefully watched for fear she might expire under treatment. Within a week the dyspnea had entirely disappeared and the patient wanted to resume her previous occupation.

The adenopathies generally disappeared under treatment, or at least became much reduced in size, but the general tendency toward the development of new adenopathies seemed to be little if at all influenced. We have often observed the disease to involve progressively the mediastinal or mesenteric nodes while the external adenopathies were apparently undergoing regression or had disappeared. The spleen similarly underwent retrogression in size when irradiated.

On the whole, the patients were made much more comfortable by radiation and seemed to have their expectancy of life much lengthened. Thus, this method of treatment justly assumes first place over surgical methods which accomplish no more, with much more hardship and mutilation to the patient. To our knowledge, however, no patient has ever been cured of Hodgkin's disease by radiation or any other method and when we pause to contemplate the multitudinous involvements in this disease hardly more can be expected under our present methods of therapy.

The early roentgen treatments in this series of cases were given with a 140 kv. crest value, and universal Coolidge tube with 0.25 mm. copper filter. The later cases in our series were treated with a 200 kv. crest value, 8 ma., Coolidge treatment tube with 0.5 mm. copper filtration run at full capacity. A few cases have been treated by the new water-cooled 30 ma., 200 kv. Coolidge tube with 0.5 mm. copper filtration. The dosage was measured with

charts similar to those of Dessauer which were modified and made more exact by measurements made by our physical department. The time consumed for treatment varied from 20 minutes to 2 hours depending on the type of tube used, the current applied, the filter thickness, number of fields radiated and target distance required to give the necessary 60 to 70 per cent. Treatment was given over adenopathies and spleen, repeated in six weeks to two months as indicated.

Radium treatments were administered by pack. The pack, however, required a longer time of application than the roentgen ray to get the same dosage but proved as efficient in end-results. This latter treatment may be given in the regulation hospital bed.

We believe the results from both radium and the roentgen ray to be similar and the biologic principles involved to be practically the same. We do not feel that our method of attack, which we believe to be representative of that commonly used in the radiation treatment of this disease, is absolutely perfect. As in the leucemias it may be possible to work out a better system of dosage with these agents.

We think it unwise to neglect the other commonly used remedies in this disease. Thus in this series, the arsenicals such as Fowler's solution, neoarsephenamine, thiarsol, etc., were used wherever indicated. We have had no experience however, with colloidal manganese used intravenously. Several cases were treated with emetin and bismuth emetin iodide on the supposition that this disease might be the result of amebiasis. We saw no improvement under this therapy. In one case a gland was removed and autolysed and the filtrate re-injected with no marked results. In another case an organism was cultured from a gland and an autogenous vaccine prepared.

On the whole we believe that radiation therapy offers the most relief in this disease with the least discomfort to the patient.

SUMMARY

1. Hodgkin's granuloma should be definitely and easily diagnosed from biopsy specimens.

2. Radiation therapy combined with the proper medical treatment offers the best chance of prolongation of life and palliation, with the least inconvenience to the patient.

3. Neither radiation therapy nor any other therapy has ever cured a Hodgkin's granuloma to our knowledge.

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ROENTGEN THERAPY OF SINUS AND INTRACRANIAL NEW GROWTHS*

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LITERATURE upon deep radiotherapy about the head has in recent years become fairly abundant but, except for references in foreign publications, it has dealt chiefly with the use of radium. Up to the present the success of perfected roentgen-ray apparatus and technique in such fields as malignancy of the uterus and the breast has very largely overshadowed its possibilities in new growths of the sinuses and cranium. For some time we have felt the impropriety of heavy radium dosage in malignant growths of the sinuses and nasopharynx. In two instances we have had the misfortune to witness severe infections which flared up after a conservative radium dosage in the antrum, given according to well-accepted technique. It is true that in both instances a considerable period of time had elapsed since the application, but the natural inference was that an infection had been aggravated, possibly by a delayed radium reaction. In another instance, a beginning infection in the orbital tissues following light radium dosage was aborted by the attending ophthalmologist by establishing drainage through ample incisions.

In this connection the experiences of Knapp[1] are of interest. He calls attention to the orbital reactions and complications following the use of radium in the antrum. Undoubtedly numerous similar cases have never been published. The danger here lies particularly in the anatomical conditions peculiar to these parts, in that drainage of the sinuses is easily obstructed. The roentgenologist is familiar with the roentgen evidences of markedly impaired drainage and of infection of adjoining sinuses in malignancy of the antrum, for instance. With the known propensities of radium to aggravate infectious processes, it is not surprising that occasionally such a complication mars the course of treatment. Further, the delicate vascular supply in these parts is a factor in producing the progressive bone necrosis occasionally found here after intensive irradiation or massive cauterization.

The pessimistic prognosis expressed by head surgeons in cases of sinus neoplasm, by whatever means treated, is well known. The early and marked bone involvement makes conservative surgery ineffective. In this type of lesion no other method has given us such encouraging results as has cross-fire preoperative radiation with a short wave-length roentgen ray, followed about three weeks later by surgical exenteration, preferably with the cautery, then by postoperative radiation. Radium needles or emanation are used as well if such seem indicated. With extensive inoperable conditions the external radiation is used alone and is usually a remarkable palliative. As yet we have not treated a large series in this manner, but the advantages found have appeared so evident to ourselves and the surgeons with whom we have worked that it has seemed worth while to call attention to them. In comparison with the reported results of tedious and necessarily expensive application of huge amounts of radium externally for new growths in this region, a penetrating roentgen ray can more economically and accurately place a uniform dosage throughout the affected area. It has been our observation that rather intensive deep treatment can thus be used with comparative safety in the presence of chronic infection, not only here but in the pelvis, where the use of radium is hazardous. The contours of the face and the relatively good resistance of the facial skin offer further advantages for effective depth dosage through three ports by which an intensity sufficient for mucous membrane desquamation in the nasopharynx can be readily produced. The resulting diffuse reaction is much different in effect from the locally destructive effect produced by radium. Sarcoma appears to be more amenable to this treatment than does carcinoma, as might be expected. Every

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case of malignancy in this region which is at all operable should be exenterated and roentgen radiation used solely for pre- and postoperative treatment.

The possible results of such irradiation upon the eye and pituitary are naturally to be seriously considered. The eye is, of course, protected by lead from the direct rays as far as possible where there is no evident orbital involvement, but this organ in the adult appears to tolerate a fairly heavy dosage. Stumpf[2] says that the injurious dose is always more than the erythema equivalent. The pituitary is possibly more sensitive, but with the possible exception of a fourteen year old girl with an extensive sarcoma in this region, we have seen no functional disturbances. In one instance of an invading malignancy, bone regeneration occurred in the superior wall of the sphenoid, and yet menstruation has been unaffected over the five months since treatment began. The sella turcica is, however, routinely protected from the direct rays on lateral exposures.

The following cases are illustrative:

Case 1. Mrs. W., aged sixty, referred by Dr. F. V. Overman. In June, 1915, Dr. Overman radically removed an invasive vascular tumor from left antrum and nasal cavity, the laboratory specimen of which was lost. Patient did not return until one year later at which time the nasal cavity was again filled with a tumor mass. The operation was repeated. As the microscopic diagnosis was sarcoma, radium was applied at once and repeated at intervals for some time by a radium therapist (dosage record not available). The tumor recurred in June, 1923, and the patient came to Dr. Overman again in August with extensive bone destruction and a tumor in the floor of the left orbit. Roentgen treatment was applied by three ports, 200 kv., through 0.5 mm. Cu and 1 mm. Al at 20 in. The pain subsided at once. The same treatment was repeated seven weeks later. This was followed by considerable malaise and a severe "head cold" lasting for two weeks. The patient was next seen March 6, 1924, at which

Fig. 1a. Extensive sarcomatous involvement of sinuses and orbit. Sept. 18, 1923. Blindness, immobility and exophthalmos of left eye.

Fig. 1b. Nov. 6, 1923. Light perception on left with good eye mobility. Complete relief from pain.

time there was no clinical evidence of disease except a small ulceration high on the septum. Bony structures showed no change, but subjectively patient was free from symptoms.

CASE II. Mrs. B., aged thirty-one, entered the Methodist Hospital Sept. 11, 1923, with a sarcoma involving the left antrum, left ethmoids and both sphenoids, with left exophthalmos, total loss of left vision and complete immobility of the eyeball. The eyelid was markedly edematous. Roentgen examination showed bone destruction in naso-antral wall, ethmoids and superior wall of both sphenoids (Figs. 1 and 2). Dr. W. F. Clevenger and Dr. Joel Whitaker considered the case quite hopeless from the operative standpoint. Two series of irradiations were given, Sept. 18–20 and Nov. 6–8, cross-firing heavily on the left antrum, left ethmoids and the sphenoids through three ports with 200 kv., through 0.5 mm. Cu and 1 mm. Al at 20 in. The relief from pain and the decrease in swelling were immediate. Before the second series the eyeball was normally mobile. A "bad cold" as in Case 1, interpreted as a vigorous deep reaction, followed the second series. On Feb. 2, 1924, no clinical evidence of pathology remained except the retinal changes which Dr. Whitaker reported had not all cleared. Left vision was slight. Considerable bone regeneration had occurred, especially in the roof of the sphenoids. The patient was comfortable. A small left supra-clavicular gland, not definitely a metastatic involvement, was treated at this time.

FIG. 2a. Shows bone destruction in superior wall of sphenoid. Sept. 14, 1923.

FIG. 2b. Bone regeneration by Jan. 30, 1924.

There are few articles to be found on the roentgen-ray treatment of intracranial tumors in our own literature. Case[3] has reported an encouraging result. Pancoast[4] has published results of radium therapy in 32 cases of hypophyseal tumors, and Quick[5] in 3. Frazier advocates the use of radium plus the roentgen ray postoperatively. Practically all of the references to roentgen therapy, however, are in the foreign literature. Fejér,[6] Ranschburg,[7] Brindel,[8] Kontschalowsky and Eisenstein[9] have recently contributed articles upon this. The work of Béclère[10] and of Nordentoft[11] is well known. Béclère has treated over 40 hypophyseal tumors by the

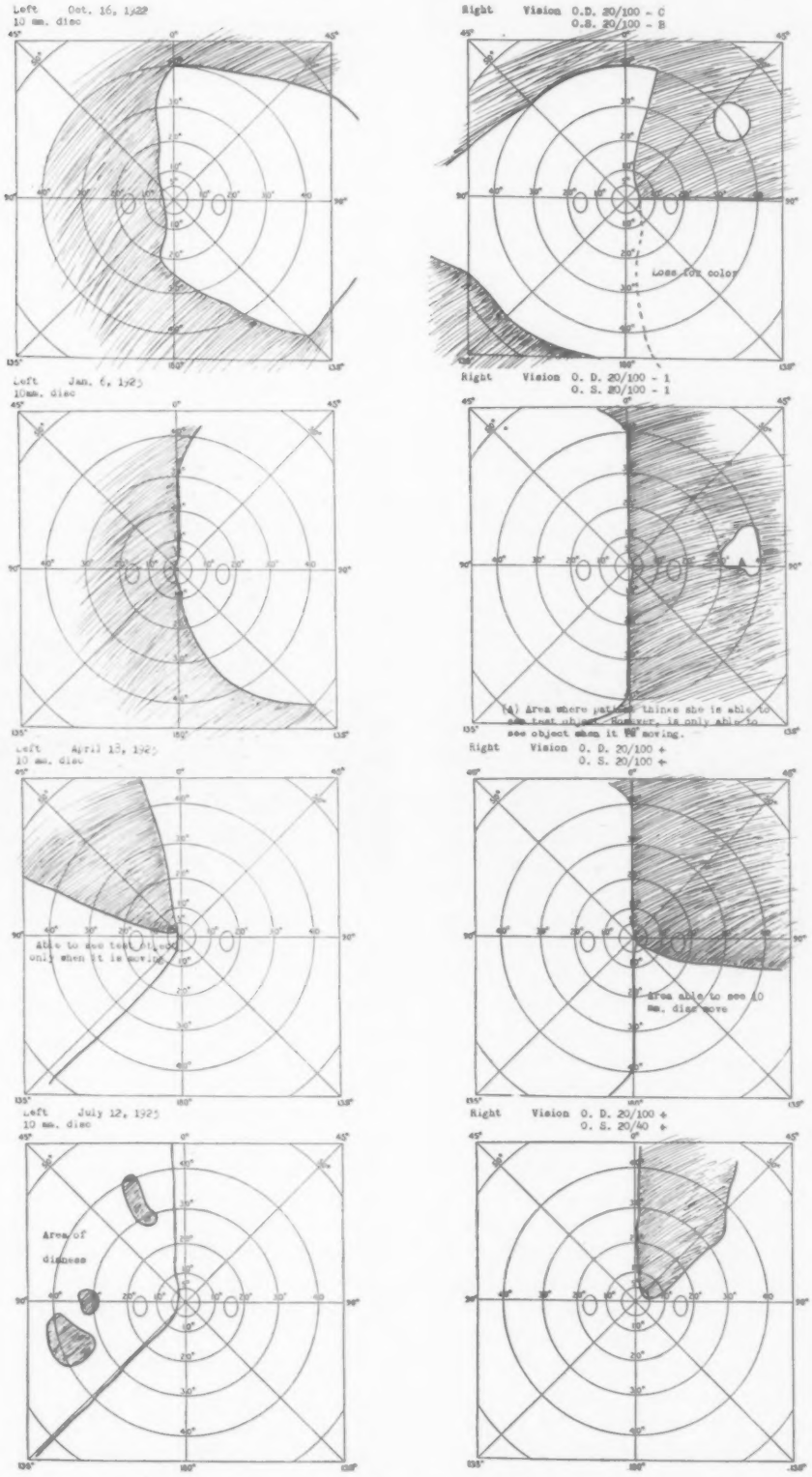
Left Oct. 16, 1922
10 mm. disc
Right Vision O.D. 20/100 - C
O.S. 20/100 - S
Loss for color
Left Jan. 6, 1923
10mm. disc
Right Vision O. D. 20/100 - 1
O. S. 20/100 - 1
(4) Area where patient thinks she is able to see test object. However, is only able to see object when it is moving.
Left April 13, 1923
10 mm. disc
Able to see test object only when it is moving
Right Vision O. D. 20/100 +
O. S. 20/100 +
Area able to see 10 mm. disc move
Left July 12, 1923
10 mm. disc
Area of disease
Right Vision O. D. 20/100 +
O. S. 20/40 +

FIG. 3. Visual fields before and after treatment of a pituitary new growth, with 10 mm. disc as test object. Vision Oct. 9, 1923, was O. D. 20/50−, O. S. 20/40−, visual fields same as July 12.

roentgen ray. The studies of Ewing[12] have been of great value. Much work remains to be done in this field. We have as yet little knowledge of the maximum tolerance of the normal brain and its functions where radiation is concerned, and the empirical data with regard to dosage in the various lesions are as yet inadequate. In practice, we can often obtain our exact diagnosis of tumor type only at autopsy. It is fortunate that glioma, apparently the most sensitive of the nerve-tissue new growths, constitutes 55 per cent of all the tumors of the brain and cord.[12]

In treatment, it is advised that considerable allowance be made for edema and consequent increase in intracranial pressure. We have not found such to be noticeable, however, in our limited observations, probably because the dosage was intentionally divided over several days each time. A careful calculation of depth intensity is, of course, an absolute essential as was clinically shown in one of our cases where, in cross-firing through the frontal, occipital and parietal areas, a temporary epilation was produced by only 50 per cent of an erythema dose on each field.

The question has been asked whether changes in the brain functions might not logically be expected to occur when such treatment is applied. There is no information available in the literature that such have ever been caused. In one of our patients with a tumor of the left cerebral hemisphere, an intensity equivalent to that of an epilation dose was produced throughout the major part of the brain. Under this dosage a word aphasia cleared up very materially each time following treatment five times over a period of about twelve months, but unfortunately the growth in this instance recurred after a pregnancy began and the mental condition deteriorated markedly before death.* In the adult brain the life cycle of the normal cells is long and we have no reason for believing them to be more sensitive than the epithelium, for instance.[13,14]

The following case is of interest because of the scarcity of references in English literature to roentgen therapy of the hypophysis and, further, because the results of foreign workers have, to our best knowledge, all been obtained after several or many irradiations:

Case III. Mrs. D., aged thirty-six, was referred Jan. 8, 1923, by Dr. Fred B. Kurtz and Dr. C. F. Neu for roentgen treatment of a pituitary tumor, as the patient objected to operation. Menstruation had stopped at twenty-three. For about three years she had had right temporal headaches, with much nervousness for the past two years. Diplopia had been present for one year. The sella in October, 1922, was much increased, with erosion of the dorsum. The vision in October, 1922, was 20/100 in each eye on examination by Dr. Daniel, with very small fields which had decreased materially by Jan. 6 on organotherapy (Fig. 3). Treatment was applied Jan. 8–10 through four ports. The intensity at the hypophysis was about equivalent to an erythema. The headaches disappeared on the second day and have not recurred since to any appreciable extent. The diplopia was soon completely relieved. A transient temporal epilation occurred. Another series was advised, but the patient stated that she was quite satisfied with the improvement effected. The vision on Oct. 9, 1923, was O. D. 20/50−, O. S. 20/40−. Reexamination of the sella in January, 1924, showed no appreciable change as compared with the views of October, 1922. The patient is mentally alert and physically active. She has received no organotherapy since roentgen-ray treatment was instituted.

The application of the known facts regarding comparative distributions of radiation intensity of radium and of a short wave-length roentgen ray shows the latter to have a distinct superiority theoretically in most types of intracranial new growths. In practice this is substantiated by the results described.

DISCUSSION

Our purpose in this report is not to demonstrate these cases as cured, but to call attention to the marked palliation which can be secured in otherwise hopeless conditions. However, the healing observed has

* This case will be reported in detail at a later date with autopsy findings.

been greater than could be obtained by any other agent. We feel that here, as in many other types of malignant growths, the roentgen ray is superior to radium for palliation without the risk associated with the latter in this location. This method of treatment deserves much more attention than it has previously received.

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II. THE NORMAL AND PATHOLOGIC ANATOMY OF THE SELLA TURCICA AS REVEALED BY ROENTGENOGRAMS*

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WITH the advent of radiography of the skull numerous attempts were made to demonstrate shadows of intracranial lesions, particularly tumors. Oppenheim was the first to observe in a roentgenogram an enlargement of the sella turcica in acromegaly. Subsequent observers have reported various changes in the roentgenographic image of the sella, and Erdheim believed that by its deformity he could differentiate intrasellar and extrasellar tumors.

It is futile to attempt to visualize changes in a roentgenogram without familiarity with the normal anatomy, its variations, and the appearance of gross pathologic conditions. Add to the complexity of the shadows of normal and pathologic anatomy, the distortion and pseudo-deformities produced by inaccurate focusing technique or unfamiliar positions, and one may realize the difficulty of arriving at a truly accurate interpretation of the roentgenogram.

The sella turcica, situated as it is within the cranial cavity and surrounded by bony prominences, is so liable to faulty projection on a roentgenographic film that this study was undertaken in an effort to compare the changes observed in anatomic specimens obtained at necropsy with those observed in roentgenograms. Purely roentgenographic studies of the sella have been undertaken in order to establish the normal, and to show pathologic changes, but many of these are of limited value, for the

*Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Roentgenology, March, 1924.

accuracy of the interpretation of the roentgenographic shadow was not confirmed by operative or necropsy findings.

The normal and pathologic anatomy, as observed from the anatomic specimens, has been described in Part I[10] of this study. The observations recorded in the present discussion have been made from roentgenograms of the specimens discussed in Part I, from roentgenograms of specimens obtained at necropsy since Part I was completed, and from one thousand other roentgenograms of the head selected from the files of the Section on Roentgenology at the Mayo Clinic.

ROENTGEN TECHNIQUE

The production of suitable roentgenograms of the sella requires a certain amount of care in adjusting the position of the head, besides a rather exacting localizing technique. The importance of these details cannot be underestimated, for we are dealing with a relatively small structure, surrounded by bony prominences in rather close proximity, and under such circumstances slight malpositions of the head or roentgen-ray tube will result in pseudo-deformities which are most confusing.

Knox, in a recent article, has carefully reviewed the technique of various observers for obtaining roentgenograms of this structure. In my experience satisfactory films are obtained by centering a small cone along Reid's base line, 2.5 cm. in front, and 1.88 cm. above the external auditory meatus. It is essential that the sagittal plane of the head be parallel with the film and perpendicular to the principal ray, for otherwise the roentgenographic shadow of the sella will be distorted and show misleading changes in its size and contour. Some form of head leveler, such as described by Pfahler, aids materially in adjusting the head. Localizing adjustments which require the superimposition of opaque points under the roentgenoscope, while perhaps ideal, are nevertheless quite impractical for routine work.

By using a Bucky diaphragm, excellent films of the head and sella may be obtained, which without doubt offer diagnostic possibilities superior to films made without it. By making stereoscopic films with a Bucky diaphragm, one gets the best possible reproduction of the internal anatomy of the skull, and by utilizing these improvements in technique there is no doubt that slight changes in the contour can be visualized earlier than is possible from flat films alone. It should be borne in mind, however, that one film of a stereoscopic pair does not represent a true lateral image of the sella, and should not be used for such when accurate anatomic measurements of that structure are desired.

THE NORMAL SELLA

Variations in Size. As a result of the many observations made on this structure, there have accumulated a number of measurements representing, according to each observer, the normal dimensions of this fossa. The majority of these have been obtained from roentgenograms, and the discrepancies between the various measurements are probably due to the adoption of different landmarks by the numerous observers. An average of the dimensions quoted by various observers gives an anteroposterior distance of 1.15 cm. and a depth of 1.02 cm.

In an effort to check the dimensions of the average normal sella, measurements were made on 500 roentgenograms, which had been reported as roentgenologically negative. The minimal anteroposterior distance was 0.5 cm. and the maximal 1.6 cm. The depth varied between 0.4 cm. and 1.2 cm. The average anteroposterior distance was found to be 1.06 cm. and the average depth 0.81 cm. These averages, which are slightly lower than those of other observers, coincide almost exactly with those obtained by direct measurement of the anatomic specimens and wax models of the pituitary fossa, as discussed in Part I of this work.

Variations in Contour. A review of a number of roentgenograms of the head will convince the observer of the numerous variations in the shape of the sella. Jewett, from a study of 100 roentgenograms, attempted to classify these into eight types, but his classification is unnecessarily complex, and, as the dividing line between so many types is very uncertain,

an accurate differentiation is difficult. Gordon and Bell have classified the various shapes into three types: the circular, oval and flat, which represent a more practical and applicable classification. In their observations, made from roentgenograms of children, the circular type was found in 70 cases, the oval in 25, and the flat in 10. In a study of the sella by means of wax impressions (Part 1), I found the oval type in 66 per cent, the round in 21 per cent, and the flat in 13 per cent. Applying this classification to a series of 500 normal roentgenograms, consisting mostly of adult heads, the oval type (Fig. 1) was found in 58 per cent, the round (Fig. 2) in 24.4 per cent, and the flat (Fig. 3) in 17.2 per cent of the cases. The preponderance of the circular type in the cases studied by Gordon and Bell is explained by the fact that their observations were limited to children, in whom the presence of a circular sella is the usual finding.

FIG. 1. Normal sella. Oval type.

FIG. 2. Normal sella. Round type.

Variations in the Clinoid Processes. Variations in the size and shape of the clinoid processes are numerous, and these can best be appreciated by a study of the anatomic specimens. The roentgenogram allows only of a lateral projection of these processes; hence, it is impossible to demonstrate the breadth of the structures by this means. The anterior clinoid processes vary in thickness and length, and may be seen normally as short blunt structures with their extremities anterior to the anterior wall of the sella, or as elongated narrow processes extending posteriorly toward the posterior clinoid processes with which they occasionally unite. It is not uncommon for an anterior clinoid process to be united with a prominent middle clinoid process, and thus form a foramen for the transmission of the internal carotid artery. While a prominent middle clinoid process can occasionally be seen in a roentgenogram, it is not possible to visualize a union between it and the anterior clinoid process.

The posterior clinoid processes project anteriorly from the superior and lateral portion of the dorsum sellae, which may vary from a broad bony structure to a thin atrophic structure. Occasionally when a thick dorsum sellae exists, the posterior clinoid processes are most inconspicuous and are represented only by the rounded upper border of the heavy bony base. This type of process is particularly common in children, as the development of the sphenoid bone has not been completed.

The shadows of the anterior and posterior clinoid processes are particularly liable to faulty roentgenographic projection, through improper technique. They are easily made to overlap by slight lateral shifts of the tube or tilt of the head, and when such an inaccurate focus is utilized, the sella appears to be bridged by a union between the bony processes (Fig. 4). This is not an uncommon fault of roent-

genograms of this region, and many of the so-called bridged sellae that have been demonstrated, are found, on more careful scrutiny of the films, to be only pseudo-

FIG. 3. Normal sella. Flat type.

deformities produced by improper technique. Jewett reported a bridged sella in 10 per cent of cases, but I do not believe this percentage could be proved anatomically.

FIG. 5. Roentgenogram of sella specimen showing bilateral bridging of clinoid processes.

Johnston[46] has attempted to associate the deformity of a bridged sella with epilepsy and diabetes insipidus, believing that the presence of the bony bridge diminishes the capacity of the pituitary fossa, and is a factor in the cause of these diseases by producing pressure on the pituitary gland. When one considers the relation of the anterior clinoid processes to the pituitary fossa, and especially the fact that they always pass just lateral to it and never

FIG. 4. Apparent bridging of the sella produced by inaccurate position of the head.

over it, the theory of a union between the anterior and posterior processes producing pressure on the hypophysis seems improbable. Roentgenograms of such anatomic variations are misleading, since the shadow of the bony union, which is in reality just

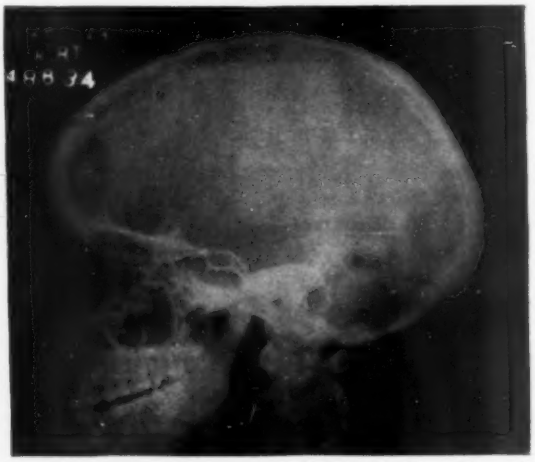

FIG. 6. Roentgenogram of a bridged sella giving the erroneous impression that the pituitary fossa is covered over and diminished in size by the bony anomaly.

lateral to the pituitary fossa, is cast over the outlet of the fossa and seems to enclose it and diminish its size. This point is well illustrated by the roentgenogram of the

specimen shown in Figure 5. I was able to demonstrate the presence of a true bony union between the anterior and posterior clinoid processes in but six (5.5. per cent) of the 110 anatomic specimens studied. In one case the bridging was present on both sides. In none of these cases was there epilepsy or diabetes insipidus, and in none was the pituitary fossa encroached on by the bony union. It is quite evident, therefore, that a bridged sella (Fig. 6) is not a factor in the cause of epilepsy or diabetes insipidus by provoking pressure on the pituitary gland, infundibulum or blood vessels going to or from the gland. The occasional finding of a bridged sella in patients complaining of these diseases must be considered coincidental.

Biedl has described the presence of a heavy erect dorsum sellae in cases of adiposity. He believes that the straight dorsum sellae, by pressure on the infundibulum, interferes with the pituitary secretion and produces the symptoms of pituitary dysfunction. The significance of this association in suspected endocrine disorders becomes somewhat doubtful when one considers the frequency with which this type of dorsum sellae is found in symptomless individuals.

Variations of the Sphenoidal Sinus. The relation of the sphenoidal sinus to the floor of the pituitary fossa has been carefully studied by Gibson, and, as will be emphasized later, plays an important part in determining the amount of destruction of the fossa by pressure. This relation is not constant, as the sphenoidal sinus varies greatly in size and shape. In the young child, the sinus is developed only in the presphenoid area, and but slightly in the postsphenoid region. At this time the floor of the sella is formed by the solid bony structure of the basisphenoid bone, and the posterior limit of the sinus is just anterior to and below the anterior wall of the sella. Roentgenograms made during this period (Fig. 7) will show the dense shadow of the basisphenoid bone below the sella, with the small sphenoid air space anterior to it. With an increase in age and the further development of the sinus, the bony structure of the basisphenoid gives way to the enlarging air cells, and according to the extent of the development, the sella is partially or completely undermined by the sphenoid air space. In exceptional cases this space may extend to the tips of the posterior clinoid processes (Fig. 8), and under such circumstances, the outline of the sella is represented in the roentgenogram by the shadow of only a thin bony plate. It is obvious how impor-

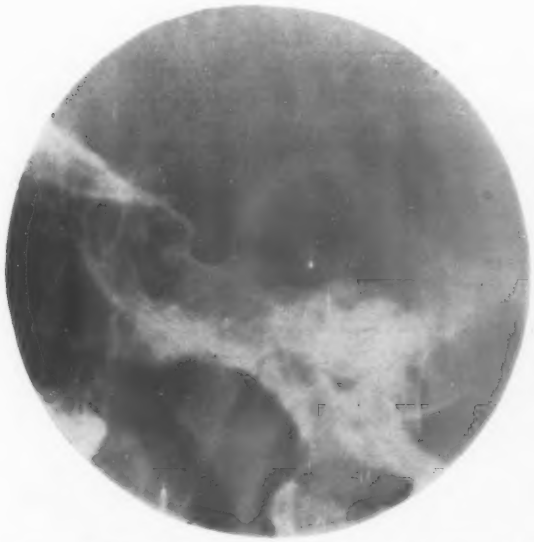

FIG. 7. Normal sella. The floor of the sella is formed by the basisphenoid bone, and the sphenoidal sinus is not fully developed.

FIG. 8. Normal sella. Exceptionally large sphenoidal sinus extending under the floor of the sella and into the posterior clinoid processes.

tant these variations become when operation on the pituitary is contemplated by the trans-sphenoidal route.

In an occasional instance of unusual enlargement, the frontal sinus may extend posteriorly into the anterior clinoid processes. This condition was observed in two of the anatomic specimens removed and in two roentgenograms observed since then.

DEFORMITIES OF THE SELLA DUE TO PATHOLOGIC CONDITIONS

Inasmuch as the sella turcica bears such an intimate relation to the pituitary gland, it is not surprising to hear expressed, occasionally, the erroneous idea that all changes in its contour are the result of pituitary disease. It is true, with certain exceptions, that pituitary tumors produce rather characteristic changes in the contour, but there are so many other causes of sellar deformities that failure to bear them in mind may result in an erroneous diagnosis with subsequent disappointment for the surgeon and perhaps disaster for the patient.

FIG. 9. Enlargement of the sella and erosion of the anterior surface of the dorsum sellae, produced by a malignant tumor of the pituitary.

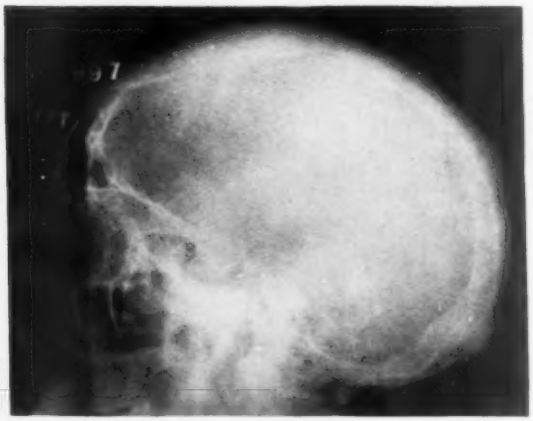

FIG. 10. Characteristic enlargement of the sella produced by a pituitary tumor which projects into the sphenoidal sinus producing a double contour of the floor of the sella.

From the roentgenologic standpoint, the pathologic conditions producing deformities of the sella may be classified as follows:

1. Intrasellar tumors involving the pituitary: (*a*) primary, benign and malignant; (*b*) metastatic; (*c*) miscellaneous; gumma, tuberculosis, and so forth.

2. Intracranial disease producing a chronic increase of intracranial pressure: (*a*) extrasellar tumors; hypophyseal duct, brain, those originating from the meninges, those originating from the bones of the skull, miscellaneous, such as abscess, aneurysm, and so forth; (*b*) hydrocephalus, congenital and acquired; (*c*) craniostenosis with oxycephaly.

3. Disease of the sphenoid bone: (*a*) primary, benign and malignant; (*b*) secondary, invasion by malignant tumors of the nasopharynx, metastasis, multiple myeloma, and fracture.

Intrasellar Tumors. As a result of the restraining action of the diaphragm sellae which firmly covers the pituitary at the outlet of the fossa, tumors of intrasellar origin produce a characteristic deformity of the sella. As a result of their growth, the sella is enlarged in a uniform circular manner at the expense of the floor and dorsum sellae (Fig. 9). The former is slowly eroded until a pouching into the sphenoidal sinus occurs with total destruction of the intervening bone. Roentgenograms of such conditions (Fig. 10) show a double line of the floor, the higher line representing the lateral border of the pituitary fossa, while the lower one is produced by the contrast of the air in the sphenoidal sinus against the lower border

of the tumor. The dorsum sellae is thinned and eroded; it first becomes concave on the anterior surface (Fig. 9), later straight and narrow (Fig. 11), and finally is pushed backwards by the increasing size of the tumor. In advanced cases the dorsum sellae may entirely disappear as a result of continued and advancing pressure (Fig. 12). Under such circumstances it is impossible to differentiate, by the roentgenogram, a tumor originating within the sella and one situated outside and provoking intracranial pressure changes. In this instance, the differentiation, which would have been possible earlier, is prevented by the marked changes produced by the large size of the tumor. The anterior clinoid processes, because of their location slightly lateral to the origin of the tumor, are not so markedly affected by its growth, and then not until the tumor has reached a fair size. When involved, they are usually eroded from below and behind with the production of short blunt processes.

By virtue of its location a pituitary tumor is unable to produce an increase of intracranial pressure, until it has reached considerable size; consequently the presence of a uniform circular enlargement of the sella, with thinning of the dorsum sellae, without evidence of intracranial pressure changes in the rest of the skull, is pathognomonic of an intrasellar tumor (Fig. 9).

A large number of pituitary tumors are associated with acromegaly; therefore, the presence in the roentgenogram of acromegalic changes, such as hyperostosis of the skull, prognathism and enlargement of the accessory nasal sinuses, aids in the definite localization of the tumor, when the foregoing changes in the sella are present (Fig. 11). The amount of sellar deformity is no index to the extent of acromegalic changes elsewhere in the body, for slight changes in the sella may exist with advanced acromegalic signs or extensive sellar deformity with little evidence of the changes of acromegaly. While the condition of acromegaly is usually accompanied by a tumor of the pituitary, cases have been reported in which the outline of the sella, as observed in the roentgenogram, was normal. Erdheim has recorded such a case, in which at necropsy a tumor originating from embryonic remnants of the pituitary was found in the sphenoidal sinus. The failure to investigate the sphenoidal sinus and nasopharynx in the other cases is offered as an explanation for failure to find a tumor of the pituitary gland at necropsy.

Metastasis to the pituitary gland, while not extremely rare, has not been commonly noted. The reason changes in the sella are not seen is probably because

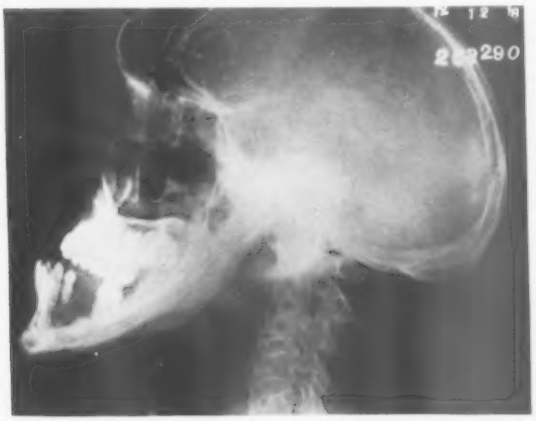

FIG. 11. Carcinoma of the pituitary associated with acromegaly. Frontal sinuses and antra are greatly enlarged and lower jaw is prognathic. Dorsum sellae is narrowed and erect.

FIG. 12. Extensive destruction of the sella, with complete erosion of the dorsum sellae, produced by carcinoma of the pituitary.

the patient dies from metastasis elsewhere before the area in the pituitary has enlarged sufficiently to produce the deformity characteristic of an intrasellar tumor. In studying the histology of the pituitary in addition to changes in the sella, in the early part of this work, I came on such a specimen, showing metastasis to the pituitary from a carcinoma of the breast. The condition had likewise metastasized to the dura, skull and sphenoidal sinus. The sella was normal. Figure 13 shows the roentgenogram of the skull of a patient suffering from carcinoma of the breast. The skull was roentgen rayed in search for metastasis. It will be noted that there is a uniform circular enlargement of the sella typical of that produced by an intrasellar tumor. There were no symptoms of pituitary dysfunction, and the neurologic examination was negative. While this case has not been proved by necropsy, it is shown as a possible case of metastasis to the pituitary. Figure 14 shows the enlarged sella found in a patient suffering from a retroperitoneal sarcoma. The patient had definite symptoms of pituitary dysfunction, and while this case has not been proved by necropsy, the clinical opinion was that metastasis to the pituitary gland had occurred.

FIG. 13. Circular enlargement of the sella produced by metastasis to the pituitary from carcinoma of the breast.

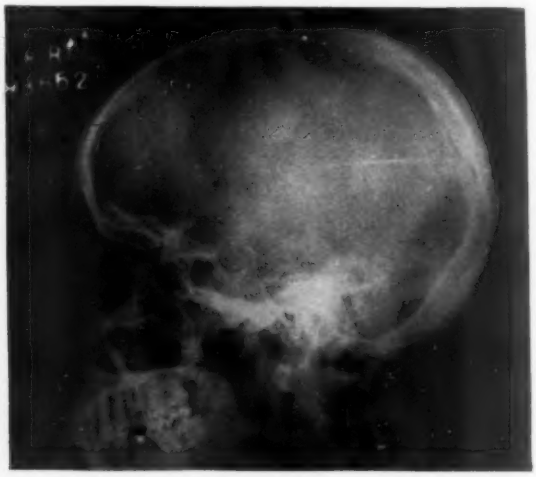

FIG. 14. Enlargement of the sella produced by metastasis to the pituitary from a retroperitoneal sarcoma.

Gumma of the pituitary is not uncommon. Figure 15 illustrates a case which, after careful clinical investigation, was diagnosed as such.

Thus it may be seen that a tumor originating within the pituitary fossa produces a deformity of the sella turcica which is characterized by: (1) uniform circular enlargement, (2) erosion and thinning of the dorsum sellae, (3) blunting of the anterior clinoid processes, (4) erosion and distention of the floor, and (5) absence of intracranial pressure changes in other parts of the skull, except in advanced cases.

The roentgenogram permits only uncertain conclusions regarding the extension of the tumor upwards. The more extensive the changes in the sella, and the more extensive the erosions in the rest of the skull, the more positively may an extension beyond the limits of the sella turcica be assured. Owing to the distance intervening between the optic commissure and the pituitary gland, when bitemporal hemianopsia occurs, the tumor has long since burst the bounds of the sella. The differentiation of benign and malignant pituitary tumors by means of the roentgenogram is impossible. The large size and the extent of the sellar deformity may arouse suspicion that the latter exists, but such points are not characteristic and are wholly unreliable.

Intracranial disease producing a chronic increase of intracranial pressure. Any

brain tumor which produces an increase of intracranial pressure by virtue of its size, or ability to obstruct the ventricles, will produce corresponding changes in the outline of the sella. The changes in the sella are purely the result of transmitted pressure, and appear simultaneously with the other pressure changes in the skull.

In contradistinction to the characteristic deformity of intrasellar tumors, the pressure associated with extrasellar tumors produces a widened and flattened sella (Fig. 16). Since the pressure is transmitted solely from above, the posterior clinoids

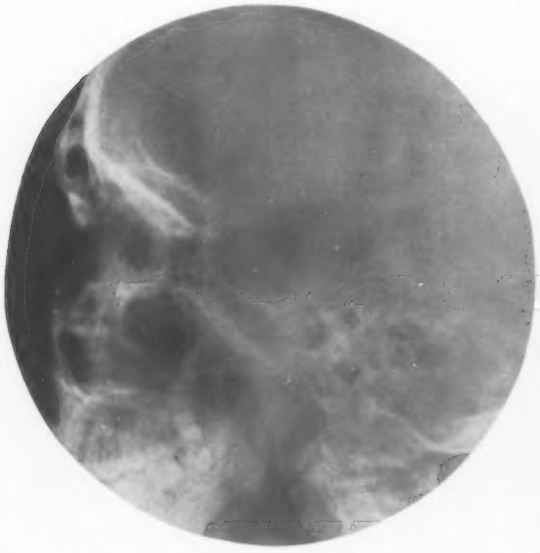

Fig. 15. Destruction of the sella produced by gumma of the pituitary.

Fig. 16. Erosion and flattening of the sella with erosion of the posterior clinoid processes, produced by increased intracranial pressure resulting from a glioma of the corpora quadrigemina.

are eroded from above rather than anteriorly, and they become shortened and pointed rather than narrowed and thinned. The anterior clinoid processes are thinned and pointed rather than shortened and blunt. The posterior clinoids, owing to the erect position and central location, are more easily eroded than the anterior, and in cases of marked intracranial pressure may exist only as mere remnants of the original structures. As the anterior wall of the sella and the tuberculum sellae are eroded from pressure coming from above, the outlet of the fossa becomes widened, and the depth is diminished rather than increased. A study of the anatomic specimens showed that, as a rule, when a unilateral tumor existed, the destruction was more marked on the side corresponding to the lesion, and the clinoid processes and floor of the sella on that side were more eroded than the other. These slight differences, which make it possible to determine the lateral location of a lesion from the anatomic specimen in a number of cases, are quite indistinguishable in the roentgenogram.

The relation of the sphenoidal sinus to the floor of the pituitary fossa determines, to a great degree, the amount of destruction produced in the floor of the fossa. In young children in whom the sinus is not fully developed, the floor is formed by the solid substance of the basisphenoid bone, and in cases of this sort the erosion from pressure produces a marked "cupping" of the floor. Roentgenograms in such cases will disclose that the floor is represented by a double instead of a single line. If a large sphenoidal sinus exists, the pressure produces complete erosion of the thin bone forming the floor, and only dura and sinus mucous membrane separates the fossa from the sphenoidal air space. Varying degrees of destruction are produced according to the degree and duration of the pressure. The earliest roentgenographic evidence is a haziness or indistinctness of the floor, due to erosion

and thinning of the bone. As the pressure continues, the erosion is increased, the sella loses its rounded contour and the pituitary gland may be pushed partially into the sphenoidal sinus, causing a double contour of the floor as it stands in contrast to the sphenoidal air space in the roentgenogram (Fig. 17).

Determination of the probable location of an extrasellar neoplasm by means of the indirect changes produced in the sella is very difficult and usually impossible. There have been described in connection with certain tumors various signs which enable

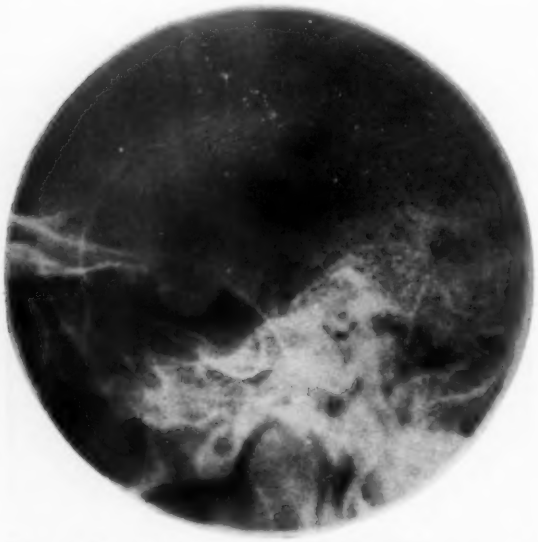

FIG. 17. Erosion of the sella with a double contour of the floor of the sella and protrusion of the pituitary gland into the sphenoidal sinus. Neurofibroma of the right acoustic nerve.

one to form, theoretically, a better idea of their probable location. Certain tumors of the pituitary arise just outside of the sella near the base of the infundibulum and are described by various authors as hypophyseal duct or craniopharyngeal pouch tumors. These, by reason of their size and ability to produce hydrocephalus by pressure obstructing the third ventricle, provoke sellar changes not unlike those produced by other extrasellar neoplasms; therefore, their localization by the type of sellar deformity is difficult. This type of pituitary tumor is frequently associated with hypopituitary, or dyspituitary, symptoms in contradistinction to the hyperactivity usually accompanying a pituitry tumors of intrasellar origin. According to Jackson, 70 per cent of the pituitary tumors associated with Froehlich's syndrome are of the cranio-pharyngeal pouch variety. This is probably because the tumor is so situated that it can easily interfere with the blood vessels and infundibulum of the pituitary gland, and thus interfere with the elimination of pituitary secretion. These tumors have a tendency to undergo nodular calcareous degeneration, and the demonstration of these changes in a roentgenogram definitely localizes the tumor. Duffy believes that the demonstration of a suprasellar calcified nodule in the roentgen film of a patient with symptoms of an intracranial tumor is highly suggestive of a calcifying hypophyseal duct tumor, and that in scarcely any other condition in the vicinity of the sella does such a localized nodular calcification occur. MacKenzie and Sosman from a study of thirty-five cranio-pharyngeal duct tumors, verified in Cushing's clinic, were able to demonstrate in the roentgenogram a characteristic calcification above the sella in 71 per cent of the cases.

Occasionally a cranio-pharyngeal pouch tumor or a basal cerebral neoplasm, because of its intimate location just above the sella, may provoke changes in the contour of the sella before the signs of a general increase of intracranial pressure are discernible elsewhere in the roentgenogram. These changes in the sella are similar to those produced by extrasellar tumors with accompanying intracranial pressure, but not as marked, and when observed in a roentgenogram are suggestive of a neoplasm at the base of the lesion. When a unilateral dilatation of the meningeal vessel markings, indicating a destruction in the return blood flow on one side, is observed, suspicions of a basal tumor are further justified. It is necessary, however, to be extremely careful in considering suspected sellar deformities from extrasellar causes, when the changes of increased intracranial pressure in other parts of the skull are absent.

Certain observers, particularly Schüller,[71] have called attention to an anterior angulation of the posterior clinoid processes and dorsum sellae, as a localizing sign in

tumors of the nervus acusticus, and other tumors originating near the cerebello-pontine angle. Besides producing an increase of intracranial pressure, it is believed that the tumors cause this anterior angulation by their growth along the base of the skull. I have observed what might be considered such a sign in but one roentgenogram (not proved), and in the anatomic study of the sella specimens I was unable to find any anatomic changes to verify this deformity, although the specimens studied included many from cases of tumors of the cerebello-pontine angle.

Besides destruction of the sella produced by pressure induced by acoustic nerve tumors, Henschen and Schüller have described, as a characteristic roentgen sign of such a tumor, a dilatation of the internal auditory meatus on the affected side. Cushing[18] has studied the significance of this sign, and the work of Carr and Grey, carried on in his clinic, proved that it occurred in but 4 of 20 cases of acoustic nerve tumor, and in one instance was contralateral to the lesion. I have had occasion to observe the size of the internal acoustic meatus in a large number of necropsies, and inasmuch as a variation in size between the two sides occurs frequently in normal individuals, this roentgenologic sign cannot be considered seriously when attempting to differentiate the sellar deformity of tumors of the nervus acusticus from that produced by other extrasellar lesions.

FIG. 18. Bony tumor originating from the sphenoid destruction of the sella; probably an osteoma.

Hydrocephalus induced by causes other than cerebral neoplasm, because of its accompanying increased intracranial pressure, will produce changes in the sella exactly simulating those induced by extrasellar tumors. With the exception of the large head, which usually accompanies hydrocephalus, distinction between the two is impossible by the roentgenogram. In true hydrocephalus, which usually occurs in young children, the amount of sellar destruction as seen in the roentgenogram, does not seem to coincide with the extreme signs of increased pressure in the other parts of the skull. However, I believe this impression is more apparent than real, for the solid basisphenoid bone which forms the floor of the pituitary fossa in children does not show evidence of erosion in the roentgenogram so early as does the floor of the sella in the adult, which is formed by thin bone and usually undermined by a large sphenoidal air space.

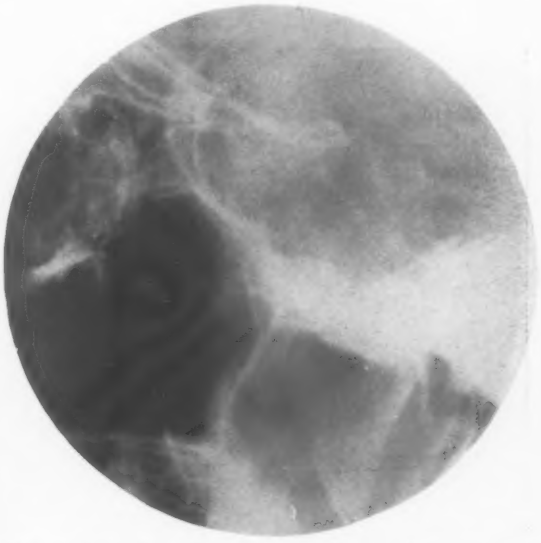

FIG. 19. Invasion of the sphenoid by a malignant tumor of the nasopharynx. The sella is almost completely destroyed, but the outline of the floor and dorsum sellae are faintly visible.

Deformities of the sella produced by increased intracranial pressure resulting from such lesions as brain abscess, cerebral aneurysm, or craniostenosis (oxycephaly) cannot be differentiated in the roentgenogram from a deformity produced by other extrasellar lesions.

Regardless of the cause of the increased intracranial pressure, the amount of destruction demonstrable in the anatomic specimens was always greater than that which could be visualized in the roentgenogram.

Diseases of the Sphenoid Bone. Disease of the sphenoid bone, either primary or secondary in origin, produces a marked change in the roentgenographic appearance of the sella. Changes secondary to a malignant tumor extending from the nasopharynx and invading the sphenoid are most common. Other conditions, such as tuberculosis, gumma, multiple myeloma, metastasis, primary malignancy, chordoma, and osteoma of the sphenoid are of comparatively rare occurrence. With the exception of the dense shadows cast by osteomas or osteosarcomas (Fig. 18), it is impossible to distinguish, by the sellar changes alone, between the other tumors of either primary or secondary origin. In such conditions the sphenoidal sinus is increased in density or appears cloudy; there is a haziness of the floor of the sella, but in general, unless the tumor has progressed to intracranial involvement, the contour of the sella is maintained, and usually the normal outline of the dorsum sellae and clinoid processes may be distinguished (Fig. 19). Intracranial pressure changes in the skull are absent. Figure 20 illustrates the replacement of the sphenoid bone by tumor tissue of a multiple myeloma. The sella deformity alone does not differ from that of other malignant tumors, but the presence of typical areas of destruction in the calvarium made the diagnosis possible.

Occasionally a basal fracture of the skull is so directed through the pituitary fossa that a defect in contour is seen in the roentgenogram. Figure 21 shows the roentgenogram of such a case, and there is the specimen of another such case in the anatomic collection used in this series.

FIG. 20. Destruction of the sella by an area of multiple myeloma; other areas of bone destruction are seen in the calvarium.

FIG. 21. Basal fracture of the skull extending through the sella turcica with displacement of the floor of the sella. The sphenoidal sinus is clouded by contained blood.

CONCLUSIONS

1. Careful technique is necessary to produce roentgenograms of the sella which are free from pseudo-defects and anomalies.

2. The normal sella varies greatly in contour, but such variations may be classified into three types: the oval, the round, and the flat; the oval type predominates (about 60 per cent).

3. The size of the normal sella varies greatly, and in view of such normal variations it is difficult to recognize, in the roentgenograms, early pathologic changes in its size and contour. (The minimal anteroposterior distance found in the roentgenograms examined was 0.5 cm. and the maximal measurement was 1.6 cm. The depth measurement was found to vary

between 0.4 cm. and 1.2 cm.) The average normal sella, as revealed in the roentgenograms of this study, measured 1.06 cm. and 0.81 cm. in the anteroposterior and vertical directions respectively.

4. Normal variations in the shape of the clinoid processes are not uncommon, and bony union between the anterior and posterior clinoid processes, producing a "bridged sella," exists in about 5.5 per cent of the cases. Such an anatomic variation seems to be of no clinical significance.

5. Owing to the characteristic deformity of the sella produced by each, the distinction between intrasellar and extrasellar tumors is possible.

6. The localization of extrasellar tumors by differentiation of sellar deformities, alone, is impossible.

7. Anatomic specimens always reveal more bone destruction than can be recognized in a roentgenogram.

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THE NECESSITY OF CLOSE COOPERATION BETWEEN ROENTGENOLOGIST AND UROLOGIST IN THE DIAGNOSIS OF DOUBLE KIDNEY*

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THE ureteropyelogram gives an accuracy and precision in the diagnosis of certain diseases of the kidney and ureter which otherwise are impossible. This is especially evident in the detection of their anomalies thus permitting their proper evaluation in explaining obscure symptoms or clinical findings. As a result of the development of this method of diagnosis, congenital changes of the kidney and ureter have assumed their comparatively recent clinical importance and as our understanding of these conditions is at present in its developmental stage, further progress must depend upon closest cooperation between roentgenologist and urologist in the detailed study of every such finding.

Ureteral duplication may be unilateral or bilateral, partial or complete. When complete and diagnosed by the urologist the roentgen ray can add but corroborative data. If, however, the second meatus is overlooked and but one pelvis and ureter are injected, then care is necessary in interpreting the finding if the anomaly is to be detected. When the duplication is but partial, the diagnosis can be made accurately and the point of fusion determined by the ureteropyelogram with each ureter and pelvis injected. However, but one pelvis and ureter may be visualized, when the same problem confronts the roentgenologist in interpreting the plate.

Of 30 cases of proved double kidney and duplicated ureter personally examined and previously reported, in 7 the anomaly was recognized only after repeated examination. Since reporting this series, 7 other cases have been diagnosed. In 2, one an instance of bilateral partial duplication, and one a unilateral partial duplication, the anomaly was found at a re-examination made necessary because of the type of pelvis secured in the first ureteropyelogram, and a third case was diagnosed definitely at operation although the primary radiographic data were so suggestive that two subsequent pyelograms were made before operation was undertaken. Two pyelograms of supposedly single kidneys were made during the past year which should be further investigated before such an anomaly can be eliminated. In each of the 7 cases missed, the caudal pelvis of the double kidney had been injected. In each of the 3 cases of partial duplication, more recently diagnosed, the caudal pelvis was pyelographed at the first examination with no regurgitation of fluid in the second ureter or pelvis. Therefore, to diagnose a large proportion of the cases of double kidney with duplicated ureter, the urologist must more and more depend upon the roentgenologist, and that the roentgenologist may interpret findings indicating or suggesting the presence of such an anomaly when but one of the two pelves and ureters is visualized, he must be familiar with the usual types of pelvis of the normal single kidney. He must be in a position to recognize such variations as approach those usually found in double kidneys, to justify his indicating to the urologist the need for further study, should any obscure clinical finding support such re-examination.

The normal single kidney pelvis varies widely in shape and character, the type depending much upon the number and disposition of the various calices. In the greater number of normal single kidneys the pelvis divides into a superior and inferior major calyx, the minor calices opening into them. The degree of division may be slight or well developed, the angle of division may be acute, as in the V type pelvis, or it may be obtuse when the vertical or T type pelvis results. If the secondary and tertiary calices are unusually well developed, the ramifying type of pelvis is formed. The superior major calyx is usually long and narrow and is directed upward and inward, while the inferior major calyx is short and wide and

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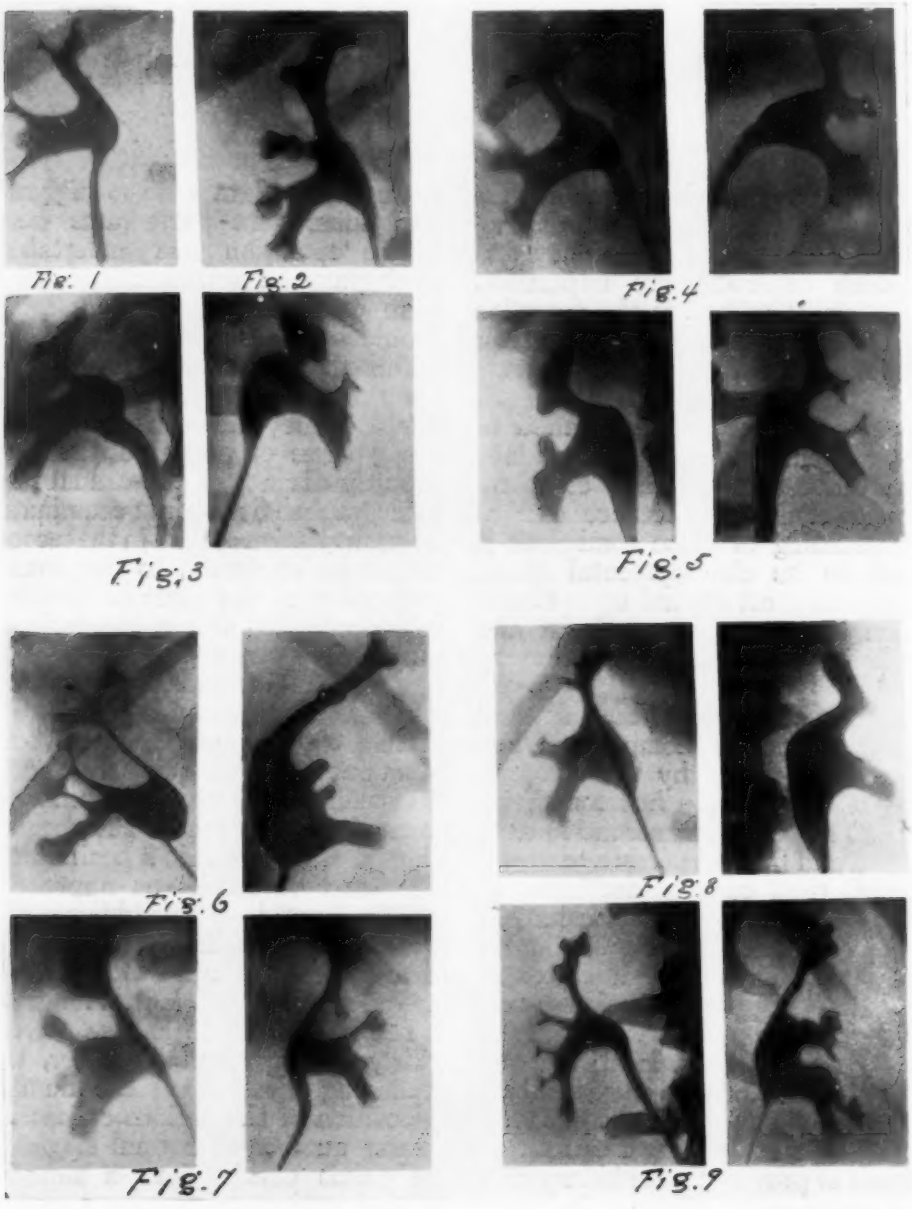

PLATE 1. Pyelograms of single kidneys showing normal tendency of the ureter to divide into two branches forming the superior and inferior major calices of the pelvis. Figures 3 to 9 inclusive, outline the right and left pelves in the same individual, demonstrating the tendency toward similar types of pelves on the two sides of the same patient. Figure 2 has a centrally located calyx which must not be considered a major calyx indicating that the ureteral bud has a tendency to divide into three major calices.

PLATE 2. In Figure *b*, the lower portion of the bifid pelvis conforms to type three of the caudal pelvis as indicated in the text. In Figure *a*, the left pyelogram outlines the pyonephrotic caudal pelvis of a double kidney, the ureters fusing at the brim of the bony pelvis. It is the same type of pelvis as is shown in Figure *b* when changed by distention. Compare with Plate 3. Figures *c* and *d*, right, have partial duplication of the ureters, the caudal pelves conforming to type two. The similarity in the outline of the left pelvis in Figure *d*, to that of the right, demands further examination before bilateral duplication can be eliminated.

is directed downward and outward, at times being almost horizontal. The lower portion of the pelvis is most often the larger, however it may be equal to or be smaller than the upper portion. There is no direct communication between the minor calices of either major calyx.

The kidney pelvis may vary from this arrangement, and such changes must be studied with care and caution. Occasionally the pelvis may divide into three major calices. However, such a finding must be unusual and as Papin states:

PLATE 3. Cut section of a double kidney, the caudal pelvis of which is visualized in Plate 2, Figure *a*, left. The outline of the caudal pelvis explains the absence of any upper calyx with all visualized calices directed downward, or downward and inward as shown in the pyelogram.

"When a median calyx is present it is a minor calyx and only when by chance it opens into the angle between the two major calices does it appear as a major middle calyx." Again there may be no pyelographic evidence of a primary division into superior and inferior major calices, the minor calices opening directly into the oval, rounded pelvis on its outer convex border—the ampullary type pelvis. This pelvis closely approaches in contour certain well defined but small and early hydronephrotic pelves. Without other early evidences of stasis it is found rarely and such a type of pelvis is not the result of a normal tendency of the ureteral bud. The ureteral bud normally divides at its distal extremity into two unequal branches, constituting a superior and an inferior major calyx.

The degree of primary cleavage of the ureteral bud varies as indicated. The extension of this division involving the entire pelvis or including the ureter in varying degrees, results in the bifid pelvis or in the partially or completely duplicated ureter. The division differs from that of the normal pelvis into its superior and inferior major calices only in the degree of the cleavage and any change in the two portions of the pelvis is influenced by the mesodermal tissue only. That is, the primary division of the ureteral bud into the two major calices of the normal pelvis is probably the result of an individual cell characteristic of this entodermal tissue itself, and the duplicated ureter is but the result of the precocious cleavage of the ureteral bud. However, the development and the arrangement of the many minor calices are most dependent upon the nature of the evolution and growth of the mesodermal tissue destined to form the permanent kidney. As the amount and arrangement of the mesodermal tissue in the double kidney vary from that in the single kidney, there will result a similar alteration in the type of pelvis predominating in the double kidney. Although every anomaly is a lawless condition and definite, standard, uniform types cannot be expected, yet the pelvis of the double kidney frequently has characteristics sufficient to differentiate it from the pelvis of the single kidney and even advanced pathological changes in the double kidney may fail to erase them. Indeed occasionally the anomaly may be thus accentuated, although, as in two of our cases, such findings are misinterpreted.

The size of the shadow of the double kidney is often well within the normal limits of the single kidney. The double kidney is seldom ptosed and the outline of the lower pole will frequently conform to that of a normally placed single kidney. A long, narrow kidney shadow should suggest the possibility of a double kidney, especially when a leaded catheter shadow is seen to enter it at an unusually high or low point. However, the catheter entering

either pelvis may approach the kidney shadow at a normal location. No conclusions can be drawn from the course, size, or irregularities of the ureterogram in detecting the anomaly. When but one pelvis is injected the radiogram may show a shadow of kidney substance which is evidently not drained by the visualized pelvis. However, the value of this finding varies depending upon which pelvis is injected

PLATE 4. Bilateral partial duplication with type three caudal pelves on each side. The ureters fuse on one side at the lower pole of the kidney, while on the other they unite near the bladder. The arrows in each instance indicate the tip of the catheter at the time of the injection.

and its size as when the caudal pelvis is shown, it is difficult to secure a good outline of the upper pole of the kidney. Thus, when most needed the finding will be least in evidence.

The tip of the superior major calyx of the single kidney, as well as the cephalic pelvis in the double kidney, occupies a

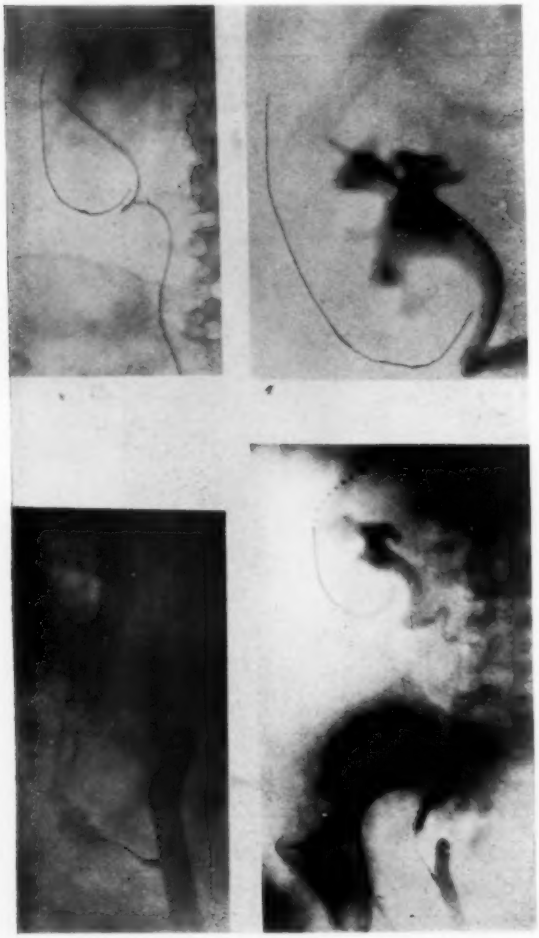

PLATE 5. Roentgenographic findings in an instance of ureteral duplication. Only the caudal pelvis was visualized after repeated attempts at pyelography which conformed to type one in outline.

relative position more median than the remaining calices or the caudal pelvis. The shadow of the caudal pelvis corresponds in its position to that of the pelvis of the single kidney, while the cephalic pelvis lies above this point. There is no communication between the pelves.

The relative size of the two pelves of the double kidney varies exactly as do the superior and inferior major calices of the single kidney. The caudal pelvis is usually the larger, often approaching the single kidney pelvis in size. However, the two pelves may be equal in size but occasionally the cephalic pelvis is the larger.

The high-lying, rudimentary, knob-like shadow immediately suggests the cephalic pelvis of a double kidney, yet the cephalic pelvis may have multiple minor calices and their arrangement may occasionally approach that of the single kidney pelvis, even to having one minor calyx extending to a point lower than the uretero-pelvic junction. The amount of kidney parenchyma between the two pelves of the double kidney varies in rather wide limits. This variation governs the degree of development of a superior calyx of the

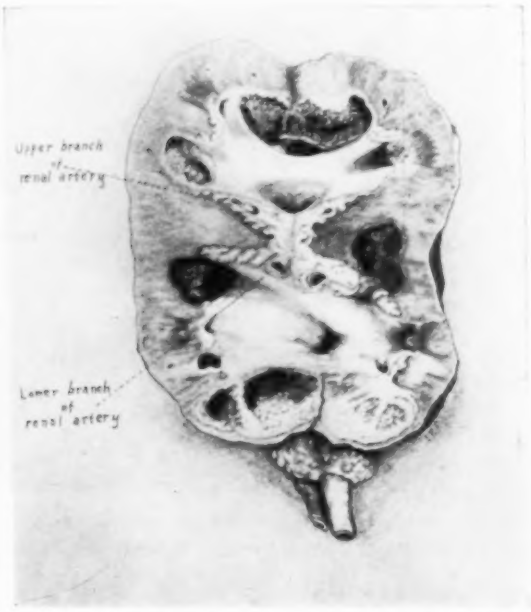

PLATE 6. Section of kidney, the caudal pelvis of which is shown injected in Plate 5.

caudal pelvis. The proportion of parenchyma superior to the caudal pelvis and not drained by the cephalic pelvis never equals the amount of parenchyma superior to the inferior major calyx of the single kidney, therefore it is in the arrangement of the superior calyx of the caudal pelvis when compared to that of the superior major calyx of the single kidney that distinctive changes will be found.

When the superior calyx of the caudal pelvis is present it follows one of two arrangements; first, it arises from the upper border of the pelvis, follows a slightly curved direction passing obliquely upward and inward, closely resembling the course of the superior major calyx of the single kidney pelvis. The superior calyx however is short, rudimentary in type and appears to drain but a small portion of kidney and while its position suggests a superior major calyx of a single kidney, its size and outline would be unusual for such a major calyx. Second and more frequently, the superior calyx springs from the upper, outer angle of the caudal pelvis and is directed upward and outward, following a straight course. It is well developed, and appears to drain a greater proportion of kidney parenchyma. The course of the calyx and the far lateral position of its tip will differentiate it from the superior major calyx of the normally placed single kidney.

PLATE 7. In Figures 1 and 6 the unusual type caudal pelvis at once suggests an anomalous condition. In Figures 2 and 8 the caudal pelves closely approach type three in outline. Figure 3, an instance of application in a 5½ year old child, has type two caudal pelvis while Figures 4 and 7 have type one pelves. In Figure 6 the cephalic pelvis is the larger, and in Figure 5, a case of bilateral complete duplication, type three caudal pelves are present on both sides. The variation in the type of the cephalic pelves is shown in this plate.

A caudal pelvis with a noninterrupted, convex superior border, the superior calyx passing directly outward or downward and outward, the curve of the superior border

being continued by the calyx is most frequent. The superior calyx ends far lateral to the pelvis, which resembles the single pelvis with its superior major calyx removed.

While these three types of pelves predominate, unusual, irregular pelvic outline will be found which will always suggest an existing anomaly.

Bilateral pyelograms of single kidneys show a uniformity in type of the two pelves of the two kidneys in most instances, even when unusual type pelves or moderately advanced pathological changes are present. In our cases of bifid pelvis in which bilateral pyelograms were made the same tendency was evident but it was not so constant a finding and the extent of the division varied on the two sides. In the 6 proved cases of bilateral duplication, there was a marked similarity in the outlines of the corresponding pelves of each kidney in the same individual. In interpreting a plate this tendency should be considered by the roentgenologist.

The pyelogram of a single kidney may approach the outline as suggested as peculiar to the double kidney. Incomplete filling of the pelvis and ureter may cause confusion in both a positive and negative way. Any unusual pyelogram should be studied with care when, with the tip of the catheter in the pelvis the ureteropelvic junction and upper ureter are not well filled.

Spasm of the circular muscles surrounding the opening of the calices into the pelvis may result in an irregular pelvic outline that might be confusing. Faulty position of the single kidney may distort the pyelogram of the normal single kidney pelvis so that it approaches the outline of the caudal pelvis of the double kidney; first, when the single kidney is displaced downward with the lower pole swinging inward, the tip of the superior major calyx has a far lateral position, and second, when the kidney undergoes abnormal rotation there is a foreshortening of the superior major calyx as seen in the pyelogram, when it appears short and blunt.

Disease of a single kidney may cause

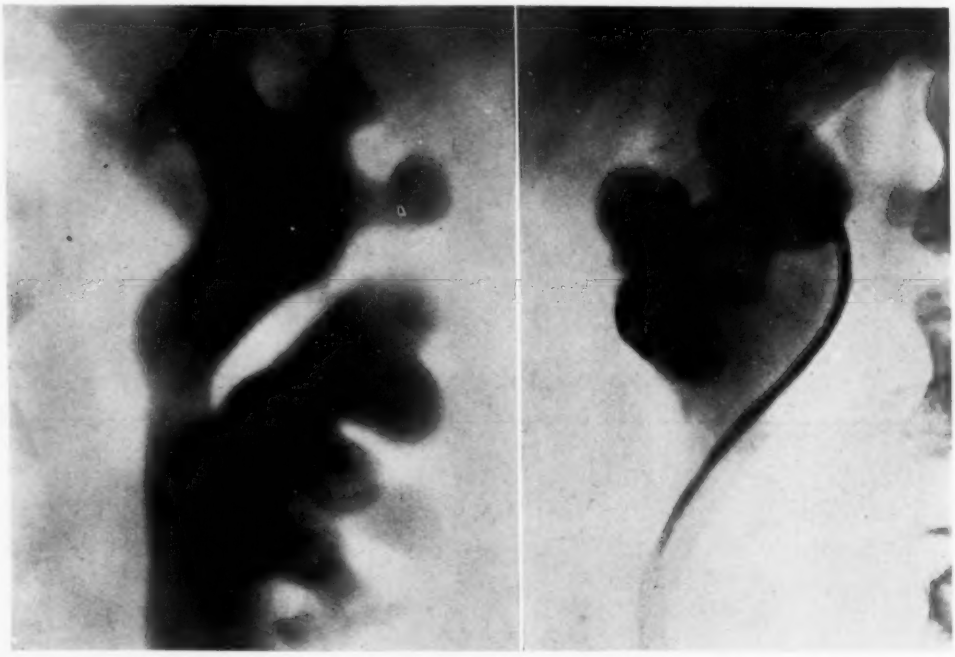

PLATE 8. Compare the outline of the pelvis as shown in Figure 2 with that of the superior portion of the bifid pelvic in Figure 1. Figure 2 was diagnosed a single kidney. With no calices extending below the uretero-pelvic junction, the presence of a double kidney should be suspected.

PLATE 9. Figure 1 shows an incompletely filled pelvis. Figures 2 and 3 are outlines of a kidney pelvis taken at different times. Figures 5 and 6 are pyelograms of tuberculous single kidneys showing how deformity from disease may occur and how it may cause confusion in detecting the double kidney. The abrupt ending of the upper calyx in Figure 6 at a point superior to the upper border of the pelvis would seem to be sufficient to differentiate it from a double kidney pelvis.

anatomical distortion giving a pelvic outline closely corresponding to that of a double kidney. This is usually a filling defect distortion which in the cases we have studied produces irregularities suggesting the nature of this condition.

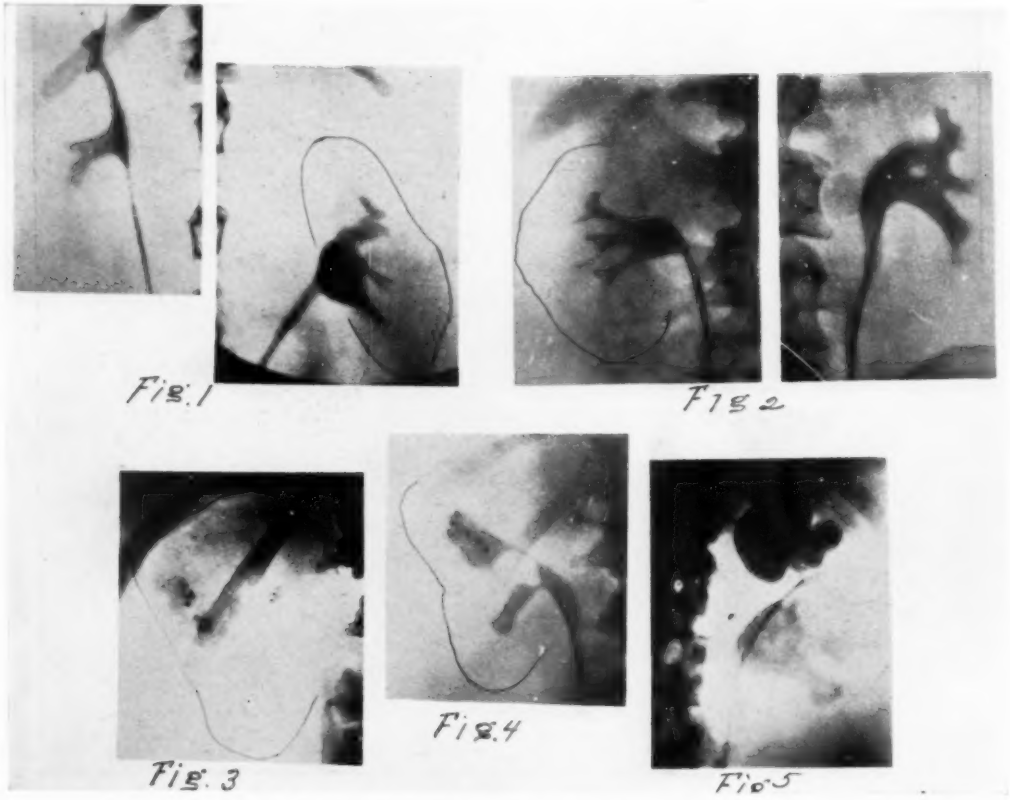

PLATE 10. Figure 1 shows how downward displacement of the single kidney with torsion may cause confusion in interpreting the relative size of the superior major calyx, approaching the type one caudal pelvis, while in Figure 2 the downward displacement has resulted in the superior major calyx lying far lateral, approaching the type two caudal pelvis of the double kidney. Figures 3, 4 and 5 again show how tuberculous deformity of the single kidney pelvis may cause it to approach the outline of the caudal pelvis of the double kidney.

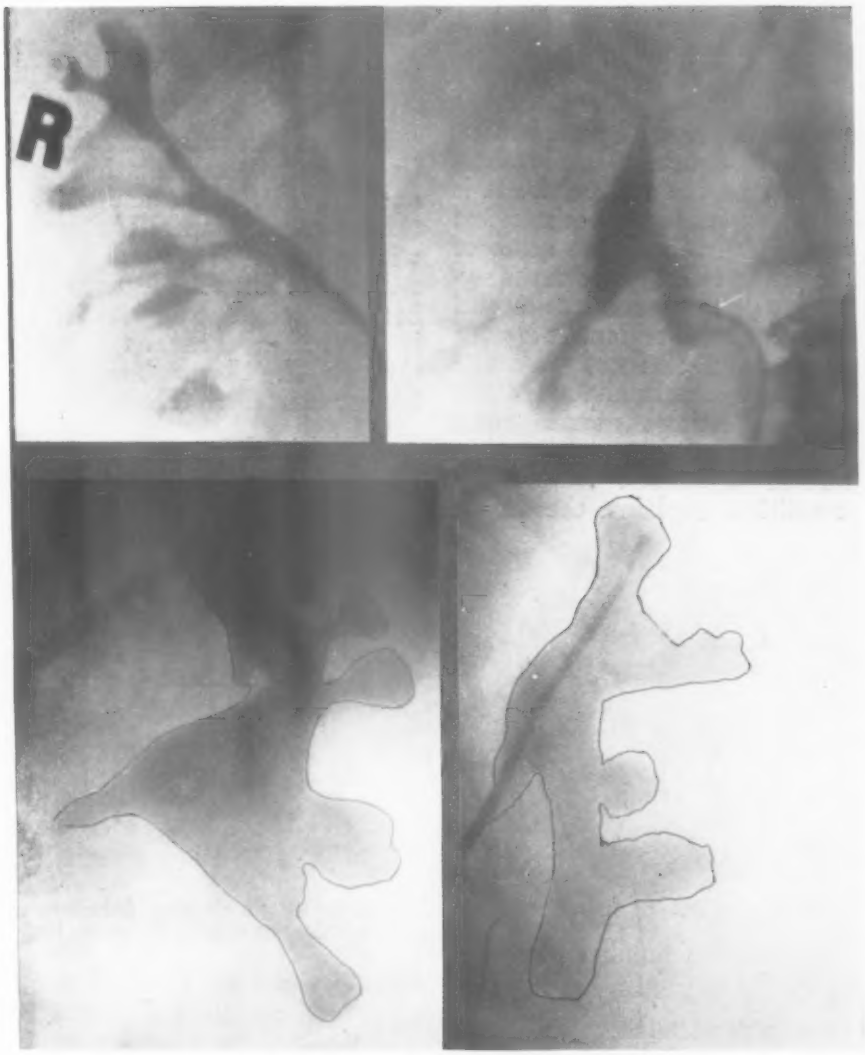

PLATE 11. Pyelograms of tumors of the kidney. In each instance either the superior major calyx retains a relative position to the remainder of the pelvis normal for the single kidney or if absent, as in one case, the ragged projection from the superior border immediately suggests its being the result of mechanical defect.

THE RÔLE OF LIGAMENTOUS CALCIFICATION IN LOWER BACK PAIN*

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ONE who studies cases of lower back pain must be impressed by the various abnormalities and structural deformities found in the lower spine and pelvis. It is our opinion that no one pathological condition can explain all of the cases of pain in this region but that many pathological conditions will be found on careful study of the lumbosacral region. It is with this thought in mind and not with the thought that we can explain all lower back pain, that we are reporting our findings in a group of cases presenting calcification of the iliolumbar ligaments. We believe that this condition explains the cause

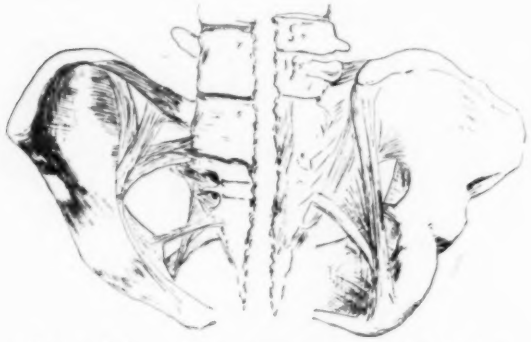

FIG. 1. Schematic drawing from Spalteholz Atlas.

of this pain in a certain number of these unfortunates.

ANATOMICAL CONSIDERATIONS

Spalteholz describes these ligaments as strengthening ligaments for the sacro-iliac joints: "This forms a powerful, flat, fibre band which has its origin from the processus transversus of the fifth lumbar vertebra; one part of the fibres extends from there to the posterior portion of the crista iliaca, another larger part broadens out on the inner surface of the ala ossis ilium and on the upper surface of the pars lateralis ossis sacri." This also frequently shows bands of fibres going to the transverse processes of the fourth lumbar vertebra.

ROENTGEN-RAY CONSIDERATIONS

Most of these cases have been discovered in our routine examination of the lumbosacral region. This examination is made in the following manner: The legs are elevated with pillows. The chest is also elevated somewhat. The tube is tilted at an angle of between 15 and 20 degrees. The central ray is focused as near as possible to pass through the lower border of the fifth lumbar vertebra. These films are made

FIG. 2. Schematic drawing from negative showing calcification of both iliolumbar ligaments.

stereoscopic. A flat film is then made in the full lateral position. The former position will usually throw the transverse processes of the fifth lumbar vertebra above the alae of the sacrum, except in those cases presenting sacralization. We believe that this position also aids somewhat in showing these ligaments when they are of sufficient density to cast a shadow.

These ligaments, when seen on the film, are triangular in shape, with the base of the triangle continuous with the transverse process of the fifth lumbar vertebra and the apex of the triangle being at the insertion of this ligament along the crest of the ilium. Many of these cases show a small area of new bone formation on the

* Read at the Fifth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 23–26, 1924.

crest of the ilium at the point of insertion of this ligament. This small projection will also be seen in many cases in which the shadow of the ligament cannot be demonstrated or in which it is so faint as to be just discernible. The majority of the cases have shown evidences of infectious arthritis varying from slight spur formation to those showing calcification of all the ligaments of the spine together with obliteration of most of the joints of the spine and pelvis.

CLINICAL FINDINGS

We have, for the purpose of study, selected 20 consecutive cases in which calcification of these ligaments has been seen. Of these, 14 were females and 6 were males. The ages varied from twenty to seventy-five, with an average of forty-six. Most of the cases occurred in the fifth decade. The youngest patient, aged twenty, had sometime previously received an injury to the lower back and on careful examination was found to have definite foci of infection also.

Fourteen of these cases complained of pain in the back, two, of neuritis, two, of rheumatism, and two, of symptoms referable to the urinary tract.

Of these cases we were able to demonstrate definite foci of infection in 15, and in 5 we were unable to demonstrate this; 2 cases presented old injury in this region, 1 was found to have tuberculosis of the kidney, and 3 gave a history of having had acute rheumatic fever.

In 12 of these cases the roentgenograms showed definite evidence of infectious arthritis involving the lumbar spine or sacroiliac joints. In a large number of cases showing infectious arthritis of the spine we have found roughening of the crest of the ilium at the insertion of these ligaments, and in some of the cases there was a suggestion of slight involvement of the ligaments themselves. It is, therefore, our opinion that this condition is largely another manifestation of infectious or hypertrophic arthritis and is not a distinct entity. In all of these cases an attempt has been made to eradicate the foci of infection. In addition, 5 cases have received local treatment of heat and massage with at least temporary improvement in the subjective symptoms. One patient has had operative removal of the involved ligament with complete relief. However, owing to the technical difficulties associated with operative procedures in this region, we do not wish to appear in the light of advising operation in any large percentage of these cases. The type of treatment should be determined in each individual case.

FIG. 3. Calcification of both iliolumbar ligaments.

CASE HISTORY

P. W. Case No. 28144. Female, aged forty-five.

Complaint. Pain in the left lumbar region.

Family History. Negative.

Personal History. Negative with the exception of some dysuria.

Present Illness. Since the age of twelve the patient has had pain and swelling in the region of the left hip accompanying the menstrual periods. The pain is sharp and stabbing in character and radiates down the leg. The patient states that there is a definite swelling along the crest of the left ilium at these times. It has increased during the last few years, especially during the last few months. The pain radiates down the back and outer side of the left hip and leg to the heel suggesting sciatic involvement. The condition is definitely related to activity and less definitely to weather changes and is relieved by rest.

FIG. 4. Calcification of ligaments of spine and pelvis with obliteration of most of the joints. A case of so-called "poker spine."

FIG. 5. Calcification of iliolumbar ligaments just discernible.

FIG. 6. Calcification of left iliolumbar ligament, before operation.

FIG. 7. Same case as Figure 6 after operation.

Physical Examination. The patient stands with a slight right lumbar, left dorsal scoliosis with a complete list to the right. There is a moderate lordosis, extension is painful, left lateral bending causes severe pain. Right lateral bending is nearly normal. With the patient lying on her back, raising of the right leg is accompanied by pain in the back of the left hip and down the back of the left leg. With the patient lying face down there is an area of marked localized tenderness over the last two left lateral processes of the lumbar spine and in the left iliolumbar angle.

Roentgen Examination. This suggests almost complete calcification of the left iliolumbar ligament. The transverse processes of the fifth lumbar vertebra are also in close approximation to the wings of the sacrum on both sides. There is also evidence of some infectious arthritis present around the lower lumbar vertebrae and sacroiliac articulations (Fig. 6).

Operation. Exploration showed the left transverse process of the fifth lumbar vertebra lying so close to the sacrum that not even a thin, blunt dissector would pass between these. The same was true in connection with its relation to the anterior surface of the ilium. The lateral process was divided close to its root with a sharp osteotome removing the entire transverse process and iliolumbar ligament. The ligament itself was extremely heavy and dense and had undoubtedly caused the calcified shadow which was seen on the roentgenogram in this area.

Four Months Following Operation. The patient complained only of slight pain and weakness on going up and down stairs, and slight tenderness over the incision. The previous localized tenderness was practically absent.

Seven Months Following Operation. There were no symptoms referable to the spine.

CONCLUSIONS

1. The iliolumbar ligaments can be demonstrated roentgenographically when of sufficient density.
2. This increased density would appear to be a part of the general picture of infectious arthritis.
3. These are best shown in the lumbosacral position with the tube tilted upward.

DIFFERENTIAL DIAGNOSIS OF ENLARGED HEART AND PERICARDITIS WITH EFFUSION*

BY C. WINFIELD PERKINS, M.D., AND BERTON LATTIN, M.D.

NEW YORK CITY

THE observations of the writers have been made for the most part at the Seaside Hospital, Staten Island, New York City, a hospital for children which operates for about three months each summer. We have had, for two summers, a cardiac service of about 50 beds and have studied about 350 children with cardiac disease. The type of case in which we were especially interested was the acute rheumatic heart.

Cardiac enlargement is a regular accompaniment of long-standing *chronic* valvular disease, whether or not an acute process be superimposed. The globular heart of mitral disease and the sabot heart of aortic disease are well-known types of silhouettes, which present no difficulties in diagnosis. In children, we often meet with hearts of great size, the enlargement being diffuse, involving both right and left sides. We have learned in recent years that these large hearts indicate not alone valvular disease, which is usually present, but also an active or inactive rheumatic infection of the whole heart structure, including myocardium and pericardium, as well as valvular endocardium. Acute rheumatic myocarditis leads to enlargement by causing loss of myocardial tone. Pericarditis may cause an enlarged roentgen-ray silhouette in two ways: (1) Pericardial effusion, especially of medium or large size; and (2) chronic adhesive pericarditis. Here the heart's action is impaired by the numerous adhesions which tend to bind

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the heart to the pericardial sac and often the latter to the chest wall. Compensatory hypertrophy of the heart muscle results. Hearts of this type reach the largest size of all.

Those cases in which the disease process has affected the whole structure, are best called cases of acute carditis, or pancarditis. Some hearts of this type attain such great size that pericardial effusion is suspected from the roentgen-ray silhouette. The largest hearts in our experience were those in which an acute carditis was superimposed upon an old chronically diseased heart. Of course, pericarditis with effusion is a disease which often affects already enlarged hearts.

With regard to the practical value of making a diagnosis of pericardial effusion, the diagnosis of small effusions is merely of academic interest. (We are not here considering purulent pericarditis.) A large effusion is a serious matter. It embarrasses the heart action by preventing proper diastolic filling of the heart, particularly of the thin-walled auricles. Paracentesis in such cases may be life-saving. Paracentesis merely to satisfy the physician's diagnostic curiosity is to be condemned.

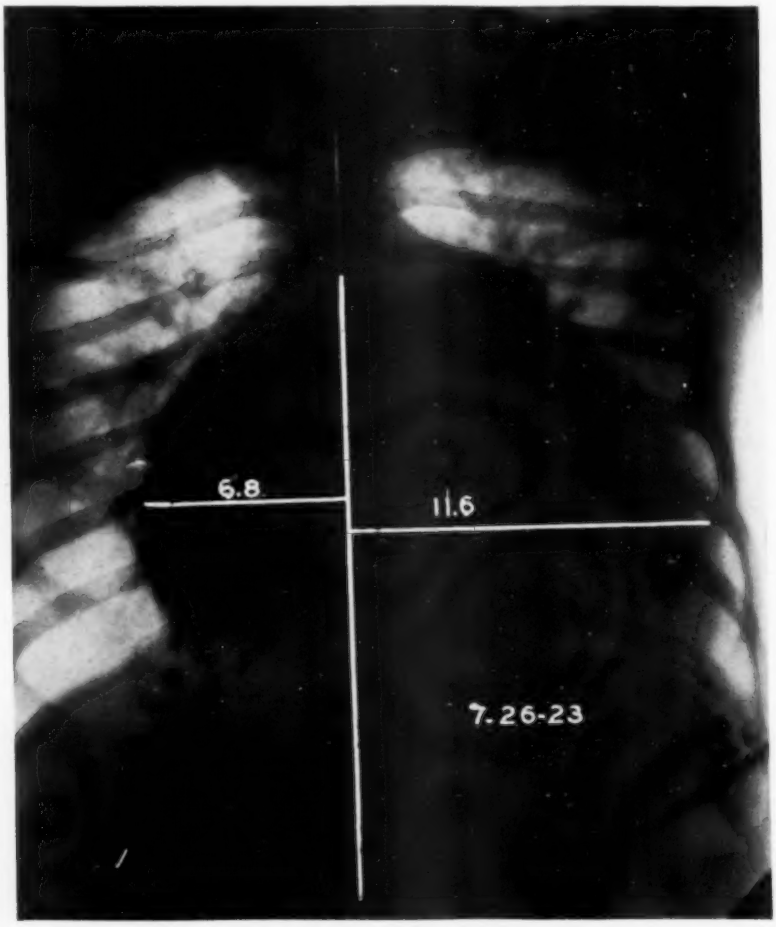

FIG. 1. Female, aged 12. Acute pancarditic heart. Note narrow base.

Let us now take up the diagnosis of pericarditis with effusion, with differential points, from the clinical as well as the roentgen-ray point of view. To help establish the diagnosis there may be signs which we associate with dry pericarditis. The only sign which we shall consider is the presence of a to-and-fro friction scratch over a larger or smaller area of the anterior

surface of the heart. We now know that the friction scratch commonly persists, even after a considerable amount of effusion has accumulated, for the reason that only in effusions of great size is the anterior surface of the heart entirely covered.

Where does the effusion first accumulate? Williamson,[1] of Chicago, has produced evidence that it first appears at the lower and anterior portion of the pericardial sac; namely, the costo-diaphragmatic angle. He finds that an early sign is downward displacement of the left lobe of the liver, shown by percussion. As indicated previously, we are not greatly interested in small effusions. The roentgen-ray gives no information as to fluid in this location.

A most valuable, fairly early sign of pericardial fluid is increasing dullness to percussion under and lateral to the manubrium sterni. It will be remembered that the upper portion of the pericardial sac enfolds the great vessels at the base of the heart. The roentgen-ray demonstrates clearly this widening shadow enveloping the great vessels.

With large effusions, we find outward extension of cardiac flatness, both to the right and to the left of the normal precordial area. The shape of this large shadow is alone not of great aid in differential diagnosis. Some of the large pancarditic hearts without pericardial effusion give tremendously wide shadows, with what the clinician takes to be obliteration of, or obtuseness of the cardiohepatic angle. Theoretically, the difference in appearance of the shadow between the erect and the reclining posture ought to assist in the diagnosis. Practically, in case of the large effusions which call for paracentesis, orthopnea is an almost constant symptom, making it difficult or impossible to obtain a plate in the recumbent position.

A more valuable aid can be obtained by roentgenoscopy, to determine whether the margins of the silhouette are pulsating. Practically, this is of value only as regards the left border. Pulsation of the right border cannot usually be seen accurately, as this border is made up of the right auricle, which is often greatly dilated and pulsating little or which is sometimes in a state of fibrillation and not pulsating at all. If vigorous pulsation of the left border and apex are present, there can be little fluid present. If pulsation be feeble or absent, fluid is probable. However, heart failure of advanced grade may also give feeble pulsation.

If the clinician can by palpation locate a definite apex beat and will then place a metal marker over the lower and outer

FIG. 2. Male, aged 12. Pericarditis with effusion. Aspirated. It was possible to see in this negative the outline of the heart shadow within the swollen sac. White arrows show broad base of heart, characteristic of effusion.

point of the apex impulse, examination by the roentgenoscope will, in the absence of pericardial effusion, show the marker squarely over the apex shadow. If there is a shadow extending well to the left of and below the marker, there is presumptive evidence of pericardial effusion. This sign is of little value unless the clinician is a skilled diagnostician.

Occasionally, it is possible to show by the roentgen-ray two distinct shadows, one of the heart itself, the other of the distended pericardium surrounding the heart. In our experience, this has been best shown on the right side, as the pulsa-

[1] Williamson, C. S. Pericarditis with effusion. *Arch. Int. Med.*, 1920, xxv, 206.

tion of the left heart border is too marked to give a very clear linear shadow. It is probable that a series of plates taken with different exposure durations would show this point in some plates better than in others.

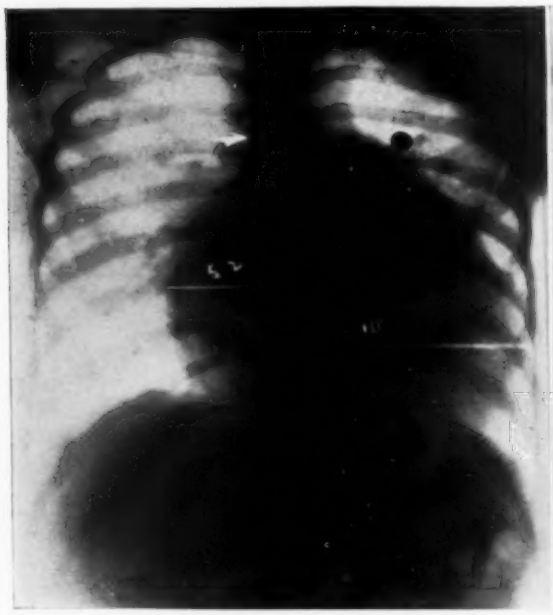

FIG. 3. Female, aged 7. Pericarditis with effusion, not aspirated. Marked orthopnea. Note broad base.

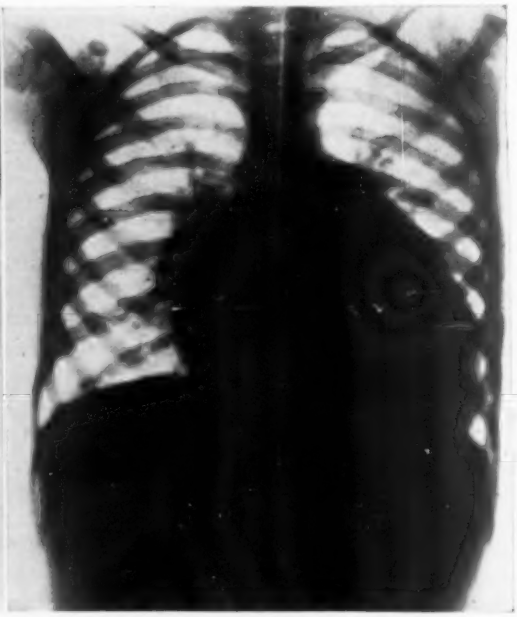

FIG. 3a. Same patient six weeks later, showing decrease in the size of the cardiac shadow after treatment. Patient then running about the ward.

FIG. 4. Male, aged 45. Pericarditis with effusion, aspirated. Note broad base and very large heart shadow.

A physical sign of some value to the clinician is based on the fact that a considerable accumulation of fluid sometimes occurs posterior to the heart, between the medial side of the left lung and the spinal column. This pouch causes compression of the base of the left lung posteriorly; rarely the pericardial sac actually reaches the posterior chest wall, and simulates pleural effusion. The roentgen-ray is of little or no help with this sign.

SUMMARY

The most important *physical signs* of pericarditis with effusion are:

1. Signs of dry pericarditis.
2. Downward displacement of the left lobe of the liver.
3. Progressive extension of flatness lateral to either side of the manubrium sterni.
4. Extension of cardiac flatness laterally to either side, especially if it extends lateral to a visible or palpable apex beat.
5. Signs of compression of the base of the left lung posteriorly.
6. Demonstration of the actual fluid by the needle or post mortem.

Roentgen-ray findings of the greatest help are as follows:

1. Wide shadow enveloping the great vessels at the base of the heart.

2. Absence of pulsation of the left border of the cardiac silhouette.

3. Actual demonstration of the heart shadow within the pericardial shadow.

4. Water-bottle shape of the heart shadow, changing shape characteristically with posture. This finding is of much less value than might be supposed.

The roentgen-ray may occasionally help decide the point of election for paracentesis. This procedure, while not a major surgical one, should not be undertaken carelessly. Any aid as to when and where to puncture is of value.

ABSTRACT OF DISCUSSION

The discussion brought out the fact that there is considerable difference of opinion as to the possibility of demonstrating the heart shadow surrounded by a pericardial effusion. Some believe that it is occasionally seen while others believe that even when a shadow, apparently of the heart, is present it cannot be distinguished from other conditions such as encapsulated fluid in the mediastinum and the contrasting shadows produced by the bronchi, etc. The point, originally brought out by Dr. Holmes, that pericardial effusion renders the cardiohepatic angle more acute rather than more obtuse, was emphasized.

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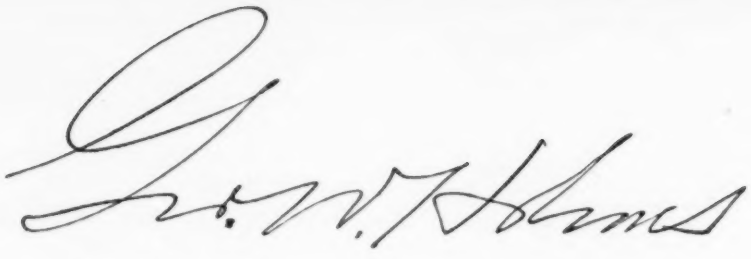

PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY
1924-1925

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Information of interest to all readers will be found on page vii. Lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on page preceding Editorial Section.

DR. GEORGE F. THOMAS*

In the untimely death of Dr. George F. Thomas, the American Roentgen Ray Society has lost one who had done much toward the scientific advancement of roentgenology. He died very suddenly in his office on Thursday, May 29, 1924, of angina pectoris, the result of an erysipelas fifteen months previous.

Dr. Thomas was born in Akron, Ohio, April 12, 1882. He graduated from Western Reserve Medical School in 1906. While serving his internship in Charity Hospital he first became interested in roentgenology. In 1909 he began specializing in this work and shortly after this he became associated with Dr. Walter C. Hill, which association continued until the time of his death.

He was president of the Cleveland Radiological Society, president of the Pasteur Club of Cleveland, a member of the American Roentgen Ray Society, the Radiological Society of North America, the American Medical Association, and the Cleveland Academy of Medicine. For a number of years he had been an active figure as a member of the Council of the latter body in improving medical conditions in Cleveland. He was head of the Roentgenological Department of Western Reserve University and visiting roentgenologist to Cleveland City Hospital.

Dr. Thomas was a physician of far-seeing vision and also a splendid organizer. His integrity in his work was of the highest, and his entire thought was given to this continually broadening field of roentgenology. He was never too tired nor too busy to give more of himself and his work, and his unselfishness surrounded all. He had just reached the point in his career where he could give more time to writing, and during the past year had been devoting a great deal of time to compiling and analyzing statistics on the cases which had accumulated during his fifteen years in this work and which, under his able direction would have resulted in a work of great scientific value.

Dr. Thomas had the rare combination of a dominant personality together with a kindliness of nature which gave him many staunch friends. He was always an inspiration to his associates. The world is bigger because of him, and his memory and personality will remain to inspire each of us to "carry on" in this, his beloved and chosen field.

He is survived by his wife, two daughters and a son.

WALTER C. HILL.

*A portrait of Dr. Thomas will appear in the September issue.

PROFESSOR REGAUD'S ADDRESS AT MEETING OF AMERICAN RADIUM SOCIETY

We wish to call special attention to the article of Professor Regaud published in this issue of the Journal. This is an

address delivered by invitation at the recent annual meeting of the American Radium Society, which contains suggestions of unusual value to roentgen and radium therapists. We are pleased to state that a portrait of Professor Regaud will be published in a later issue of the Journal.

CHANGING PRACTICE IN TREATMENT OF MALIGNANT DISEASE

The medical literature of the past year contains numerous indications of an almost revolutionary change in our methods of dealing with malignant neoplasms. For many years, indeed for many centuries, cancer therapy consisted entirely in an attempt to extirpate, usually by excision, all of the cancerous tissue. As knowledge of pathology advanced and it was discovered that cancer cells are likely to be present far beyond the apparent limits of the growth, surgical excision became more and more complicated. Coincidently attempts have been made, very earnest in the past few years, to so educate the public that excision may be performed at an early stage of the cancerous growth when the hope is greatest for complete extirpation by operation.

In spite of all this there are many indications in the literature of a profound, wide-spread, discouragement over the results obtained. Ewing says: "As for the results, and the capacity of this therapeutic method to cope with cancer, few will deny that the verdict is 'unsatisfactory.' The mortality from cancer, as judged from statistics, has been but slightly influenced, while from the narrower view point, that of the cancer patient, the same verdict must be returned." Herbert J. Paterson, speaking before the Section of Surgery of the British Medical Association gives some facts which support Ewing's statement. "The Registrar-General's returns show that in the year 1921, of each million persons living, 1215 died of cancer, as compared with 828 per million persons in the year 1900, an increase of nearly 30 per cent. Even granting that cancer is on the increase, and that death certification is more accurate, it is not easy to understand this proportional increase if modern operations have effected the cures which are claimed. A comparison of operative statistics seems to point to the same conclusion. Most of us have had isolated cases of freedom from recurrence for ten or even twenty years, but on the whole the proportion of those free from recurrence after five years appears to be about the same as it was twenty-five years ago. When I was house-surgeon I traced the results of the operations for mammary cancer performed by my chief, the late Mr. Alfred Willett. I found that 42 per cent of the patients were free from recurrence after three years, and 33 per cent after five years. In 1902 Mr. T. Bryant published a series of cases showing 50 per cent free from recurrence after five years and 32 per cent alive and well after ten years. It is not without significance that both of these surgeons practised what today would be considered a very inadequate operation. The axilla was not cleared out as a routine measure, but only when there was evidence that the glands were diseased. It is interesting to compare these figures with those of Halsted, as the result of the more radical operation known by his name. In spite of a more extensive operation his results appear no better than those I have quoted. He reported 46 per cent of the patients dead within three years and 41 per cent alive and free from recurrence after three years. Mr. Harrison Cripps was able to report that 42 per cent of his cases were alive three years after operation, and almost all of them were perineal excisions. Not many of us can show better, if as good results as these. Unless we can prove our efforts to be more successful we are living in a fool's paradise."

We could quote numerous other writers to show that there is a very general realization that we have made little headway in reducing the mortality rate of cancer. Something may be hoped for by the general education of the public so that cancer may be treated at an early stage but at the best the majority of patients who come for treatment will be those with the disease well established.

One of Paterson's conclusions in the article quoted above is that nothing is gained by removal of adjacent lymph-nodes at the time of removal of the primary growth. The nodes are a protective barrier to the spread of cancer cells and only harm is done by removing them. He thinks they may be removed at a later date with much greater safety and cites several cases of cancer of the tongue with cervical gland involvement that have apparently been cured by dealing with them in this way.

It seems to be the general opinion that surgery has reached its highest point beyond which very little can be expected of it in the treatment of cancer. It now seems likely, also, that radium and roentgen rays are approaching the maximum that may be hoped for from them in the direction of direct destruction of cancerous tissue. Ewing has pointed out that radiation acts in three ways each quite distinct from the others; it has an autolytic effect observed particularly in the melting away of certain embryonal tumors; a caustic or destructive effect which is analogous to the extirpation of tumors by surgery; and a restraining effect observed in certain malignant tumors in which the tumor cells are replaced wholly or in part by connective tissue. It seems probable that it is in the direction of a utilization of this latter effect of radiation that advances may be looked for in the future.

In the meantime it would seem that we must begin to revise our methods of treatment of cancer if we are to make full use of the knowledge and experience already acquired. Nothing can be gained by persisting in radical destructive operations or in radical destructive roentgen or radium therapy in deep-seated cancer if by so doing we are not decreasing the mortality rate from the disease.

In the face of all this, however, there are certain hopeful signs in an apparent increase in the number of cures of certain types of cancer that were formerly almost hopeless, by a combination of old and new methods. For instance, in cancer of the tongue with involvement of the cervical glands it is now common practice to treat the primary disease by radium or electrothermic coagulation or by a combination of these agents, and to treat the cervical glands with roentgen radiation and subsequently to excise any that resist the radiation treatment. This avoids early breaking down of the defensive bulwark of glands entailed by a block dissection. In cancer of the cervix uteri radium treatment of the primary disease and short wave roentgen treatment of possible pelvic metastases has very largely replaced surgical methods with resultant elimination of the appalling operative mortality and great increase in the number of permanent cures. The good results of radiation treatment in certain types of embryonal tumors is well known.

In addition to the changes in practice comprised in the gradual substitution of irradiation and electrothermic methods for excision there has also taken place a radical change in our conception of the reasons for the retrogression or disappearance of malignant neoplasms under various forms of treatment. Murphy's work at the Rockefeller Institute apparently shows that the main effect of radiation of malignant tumors is due to a reaction set up in the surrounding healthy tissues rather than to any direct effect upon the tumor cells. Mouse tumors irradiated for long periods *in vitro* when transplanted into mice grow as well as un-irradiated controls, whereas if they are transplanted into skin areas which have been previously irradiated they fail to grow. All experienced radiologists are familiar with the fact, recently emphasized by Ewing, that old, debilitated or cachectic patients do not respond to radiation treatment of malignant disease as do the young and strong, and that in this type of patient irradiation may do more harm than good.

It is now thoroughly understood that we must abandon the idea of administering a "lethal" dose of radiation to cancer cells within the body and that we must depend for our good effects upon certain bodily reactions which the rays from radium and the roentgen tube have been shown to have. We have gradually arrived at a realization that the problem is not so simple as the conception of the "lethal dose" had led us to believe. We now know that to

deal with it adequately we must draw upon the knowledge and experience of the pathologist, the biologist, the physicist, the surgeon, the radiologist, and even the physiological chemist. We recognize now the necessity for accuracy of diagnosis of the various types of malignant growths and the need for careful consideration of each individual case with regard to the location of the disease, the presence or absence of metastases, the proximity of important structures which may be injured by treatment, and the general state of health of the patient to be treated.

With all of its complexity, however, the problem has a more hopeful aspect than at any time in the past. There are indications that in the line of radiation therapy further advances may be expected, but even at the present time we may feel confident that by a judicious use of the methods now in hand, and especially by their wise combination we are in better condition than ever before to deal with malignant disease.

A CORRECTION

On page 548 of the June issue at the end of Dr. Henry Hazen's article, "The Roentgen-ray treatment of Keloids," there are under the heading, "Bibliography," two titles. These titles should have been preceded by the following sentence: "A complete bibliography will be found in the following books."

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY *visiting New York City, are invited to make the office of* THE JOURNAL (*69 East 59th Street, New York*) *their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

Gösta Forssell

CALDWELL LECTURER, 1924

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

ANNUAL MEETING AMERICAN ROENTGEN RAY SOCIETY

As the time draws near for the Annual Meeting it is evident that we are to have an unusually good program this year of which a general resumé was published in the July number of the Journal. We are now informed that Dr. James Heyman, head of the Gynecological Department of the Radium Home, Stockholm, will accompany Dr. Forssell and will read a paper on "Final Results in the Treatment of Carcinoma of the Uterine Cervix." It is hoped that many of those attending the meeting will bring members of their families since special plans are being made for entertainment.

We again call attention to the fact that Dr. Gösta Forssell will deliver the Caldwell Lecture on the subject of "Experiences of the Permanency of the Radium Cure in Malignant Tumors," and we are pleased to be able to publish a portrait of Dr. Forssell in this issue.

AMERICAN ROENTGEN RAY SOCIETY

TWENTY-FIFTH ANNUAL MEETING,

NEW OCEAN HOUSE, SWAMPSCOTT, MASS.

SEPTEMBER 3, 4, 5, AND 6, 1924

PRELIMINARY PROGRAM

WEDNESDAY, SEPTEMBER 3, 1924, 9 A.M.

Welcome: DR. ENOS H. BIGELOW, President, Massachusetts Medical Society.

Response by the President: DR. HOLLIS E. POTTER, Chicago, Ill.

Welcome: DR. FREDERICK W. O'BRIEN, President, New England Roentgen Ray Society.

Response by the President: DR. HOLLIS E. POTTER.

Introduction and Installation of the President-Elect, DR. GEORGE W. HOLMES, Boston, Mass.

1. WOLBACH, DR. S. BURT, Boston, Mass. (by invitation). "Chronic *X*-ray Dermatitis and the Histogenesis of *X*-ray Carcinoma." Discussion: DR. FRANCIS C. WOOD.

2. PORTER, DR. CHARLES A., Boston, Mass. (by invitation). "The Surgical Treatment of *X*-ray Lesions." Discussion: DRS. EMIL G. BECK, PERCY BROWN and E. A. CODMAN.

3. PFAHLER, DR. GEORGE E., Philadelphia, Penna. "Electrocoagulation in the Treatment of Keratoses and Malignant Degeneration following Radiodermatitis." Discussion: DR. H. H. HAZEN.

4. BALL, DR. CLARENCE F., Rutland, Vt. "Abdominal Deep Therapy Injuries with Report of Necropsy Findings in a Fatal Case." Discussion: Dr. Charles L. Martin.

5. GREENE, DR. D. CROSBY (by invitation), Boston, Mass. "Radiation Therapy of Carcinoma of the Esophagus."

WEDNESDAY, SEPTEMBER 3, 1924, 2 P.M.

1. DUANE, WILLIAM, PH.D., Boston, Mass. (by invitation). "The Modern Conceptions of *X*-radiation." Discussion: DR. WILLIAM D. COOLIDGE.

2. FAILLA, DR. G., New York City (by invitation). "A Precision Method for the Administration of Roentgen Rays." Discussion: DR. OTTO GLASSER.

3. BOVIE, DR. W. T., Boston, Mass. (by invitation). "The Relation between Physiological Dominance and the Biological Effects of Rays." Discussion: DR. GEORGE E. PFAHLER.

4. WOOD, DR. FRANCIS C., New York City (by invitation). "Effect on Tumors of Radiation of Different Wave-lengths." Discussion: DR. G. FAILLA.

5. MARTIN, DR. CHARLES L., ROGERS, FRED T., PH.D., and FISHER, N. F., M. S., Dallas, Texas (by invitation). "The Effect of Roentgen Rays on the Adrenal Gland." Discussion: DR. RALPH E. HERENDEEN.

EXECUTIVE SESSION

Reading of Minutes.
Unfinished Business.
Reports of Officers and Committees.
Election of New Members.
New Business.

WEDNESDAY, SEPTEMBER 3, 1924, 8 P.M.

"The Nomenclature of Bone Sarcoma." DR. E. A. CODMAN, Boston, Mass. (by invitation).

Registration of Bone Tumors.

THURSDAY, SEPTEMBER 4, 1924, 9 A.M.

1. WILLIAMS, DR. FRANCIS H., Boston, Mass. "(*a*) Treatment by Radium of Lesions of Four Years' Duration on the Hands of an *X*-ray Worker. (*b*) A Way of Using Radiations from Radium in Superficial Lesions. (*c*) A Mechanical Stereoscopic Fluoroscope. (*d*) Restoration and Improvement of Vision by Radium Treatment in Opacity of the Cornea. A Preliminary Statement." Discussion: DR. CHARLES A. PFENDER.

2. EVANS, DR. WILLIAM A., and LEUCUTIA, DR. T., Detroit, Mich. (by invitation). "Roentgen Treatment of Lymphomatous Conditions." Discussion: DR. GEORGE R. MINOT.

3. BUNTING, DR. C. H., Madison, Wis. (by invitation). "Radiation and Resistance." Discussion: DR. HENRY K. PANCOAST.

4. HEYMAN, DR. JAMES, Stockholm, Sweden (by invitation). "Final Results in the Treatment of Carcinoma of the Uterine Cervix at Radium Hemmet in Stockholm." Discussion: DR. GEORGE A. LELAND, JR.

5. LENZ, DR. MAURICE, New York City (by invitation). "The Stimulation of the Thymus by Roentgen Rays." Discussion: DR. GEORGE W. GRIER.

6. PIRIE, DR. A. HOWARD, Montreal, Canada. "The Action of *X*-rays on Corns." Discussion: DR. PERCY BROWN.

7. Morgan, Dr. James D., Philadelphia, Penna. "Further Observations on the Treatment of Malignant Neoplasms by a Fractional *X*-radiation Technique."

Thursday, September 4, 1924, 2 P.M.

Sight-seeing Trip and Clam Bake; Golf Tournament.

Thursday, September 4, 1924, 8 P.M.

The Caldwell Lecture

Forssell, Prof. Gusta, Stockholm, Sweden. "Experiences of the Permanency of the Radium Cure in Malignant Tumors."

Friday, September 5, 1924, 9 A.M.

1. Sosman, Dr. Merrill T., and Putnam, Dr. Tracy, Boston, Mass. "Roentgenological Aspects of Brain Tumors: II. Meningioma (Dural Endothelioma)."
2. Bailey, Dr. Percival (by invitation). "The Results of Roentgen Therapy on Brain Tumor." Discussion: Dr. Harvey Cushing.
3. Aspray, Dr. Joseph, and Herpel, Dr. F. K., Spokane, Washington (by invitation). "A Superior Routine Technique in the Roentgenological Examination of the Nasal Accessory Sinuses, and the Value of Such Examination in the Diagnosis of Sinus Disease." Discussion: Dr. Alexander S. Macmillan.
4. Mixter, Dr. W. Jason, Boston, Mass. (by invitation). "Examination with Lipiodol in Spinal Cord Tumors." Discussion: Dr. P. M. Hickey.
5. LeWald, Dr. Leon T., New York City. "Congenital Dilation of Diploic Veins. Importance of Recognition." Discussion: Dr. Isaac Gerber.

Executive Session; Election of Officers; New Business.

Friday, September 5, 1924, 2 P.M.

1. Golden, Dr. Ross, New York City. "The Evolution of the *X*-ray Shadows in Primary Carcinoma of the Bronchus." Discussion: Dr. William H. Stewart.
2. Leonard, Dr. Ralph D., Boston, Mass. "Further Observations on the Use of the *X*-ray in Pertussis." Discussion: Dr. Kennon Dunham.
3. Jaches, Dr. Leopold, New York City. "Review of the Work of Gräff and Küpferle on Tuberculosis." Discussion: Dr. John B. Hawes, 2d.
4. Amberson, Dr. J. Burns, Loomis, N. Y. (by invitation). "The Nature and Differentiation of Pleural Annular Shadows." Discussion: Dr. William A. Evans.
5. Moore, Dr. Alexander B., Rochester, Minn. "A Further Study of the Roentgen Findings in Bronchiectasis." Discussion: Dr. W. F. Manges.

Friday, September 5, 1924, 8 P.M.

Annual Banquet

Cabot, Dr. Richard C., Boston, Mass. "Impressions as to the Value of the *X*-ray in Internal Medicine."

Hickey, Dr. P. M., Ann Arbor, Mich. "Roentgen History—Reminiscences."

Saturday, September 6, 1924, 9 A.M.

1. White, Dr. Franklin W., Boston, Mass. "The Clinical Importance of Chronic Changes in the Appendix." Discussion: Dr. H. M. Imboden.
2. Carman, Dr. Russell D., and Counsellor, Dr. V. S., Rochester, Minn. "Roentgenologic Diagnosis of Disease of the Biliary Tract with the Aid of the Sodium Salt of Tetrabromenolphthalein." Discussion: Dr. Arial W. George and Dr. William H. Stewart.
3. Case, Dr. James T., Battle Creek, Mich. "Diagnosis of Diseases of the Alimentary Tract." Discussion: Dr. P. F. Butler.
4. Kantor, Dr. John L., New York City. "A Clinical Study of Redundant Colon." Discussion: Dr. Franklin W. White.
5. Merrill, Dr. Adelbert S., Manchester, N. H. "Syphilis of the Stomach." Discussion: Dr. L. T. LeWald.

Saturday, September 6, 1924, 2 P.M.

1. Smith-Petersen, Dr. M. N., Boston, Mass. (by invitation). "Clinical Diagnosis of Common Sacroiliac Joint Conditions." Discussion: Dr. Roland Hammond.
2. Nichols, Dr. Bernard H., Cleveland, Ohio. "Some Anomalies of the Kidney." Discussion: Dr. L. B. Morrison.
3. Pancoast, Dr. Henry K., Philadelphia, Penna. "Report of the Safety Committee."
4. Mutscheller, A., ph.d., New York City (by invitation). "Physical Standards of Protection against *X*-ray Dangers." Discussion: Dr. P. F. Butler.
5. Doub, Dr. Howard P., Detroit, Mich. "Immediate Metabolic Disturbances Following Deep Roentgen Therapy; A Preliminary Report of an Experimental and Clinical Study." Discussion: Dr. Robert G. Allison.

Local Committees

Committee on Scientific Exhibit: Dr. Alexander S. Macmillan, Chairman; Dr. Merrill T. Sosman.

Committee on Arrangement and Entertainment: Dr. P. F. Butler, Chairman; Dr. Arial W. George, Dr. Thomas R. Healy.

COMMERCIAL EXHIBIT AT THE ANNUAL MEETING, AMERICAN ROENTGEN RAY SOCIETY

Attention of our readers is called to the Commercial Exhibit to be shown in connection with the Annual Meeting at the New Ocean House, Swampscott, Massachusetts, September 3 to 6, 1924. That the exhibit will be not only of practical but also of educational value may be seen from the following resumé.

1. The Acme-International *X*-Ray Company are planning to exhibit their latest high voltage deep therapy equipment, including the water-oil-water-cooling system for the water cooled deep therapy tube. They also expect to display several very interesting developments in the way of new diagnostic equipment, and in addition to the above, the new surgical instrument—the Radio Knife—will be shown and demonstrated.

2. George W. Brady & Company will exhibit in Booth No. 12 their Potter-Bucky

Diaphragm in connection with a Mercury Circuit Breaker for making the exposures automatically. They are also exhibiting the Mastoid Localizer and the Sphenoid Localizer as designed by Dr. Amadee Granger of New Orleans, and a number of other interesting accessories, including a Potter-Bucky Diaphragm of a new type suitable for head work, or for body work with small cassettes.

3. The Buck *X*-Ograph Company, in addition to the usual display of *X*-Ograph dental film packets, angle meters, developing chemicals, etc., will exhibit *X*-Ograph ultra rapid durable intensifying screens and a complete line of *X*-Ograph cassettes, including *X*-Ograph pneumatic cassettes. The important feature of this new cassette is a pneumatic pressure pad which, when inflated, insures perfect contact between the film and screens.

4. Campbell and Haulen beek, medical photographers, Palisades Park, N. J., will show reproductions of fine quality in the form of lantern slides and prints.

5. The exhibit of the Eastman Kodak Company will consist of a display of negatives, made with Eastman Safety Dupli-Tized *X*-ray film, together with a showing of the possibilities of clinical photography, both in still and in motion pictures, with the new Cine-Kodak.

6. The Engeln Electric Company will exhibit in Booth No. 5 the new Engeln line of diathermy equipment. The latest additions are the Engeln Intermediate and the Engeln Mobile Diathermy apparatus. They will also show the new Engeln Bucky Potter diaphragm, capable of being operated in any position, in counterbalanced vertical mounting.

7. In Booth No. 4 the Hanovia Chemical and Manufacturing Company will exhibit their quartz lamps, the Alpine Sun and Kromayer. They will also exhibit the new addition, the Luxor Lamp. New mechanical features have been added to these lamps to adapt them more perfectly to the broadening therapeutic field.

8. Paul B. Hoeber, Inc. will display The American Journal of Roentgenology and Radium Therapy, and a number of important *x*-ray publications, including Desjardin's "Anatomic Life Size Cross Section Charts" printed over a cm. scale for the proper measurement of penetration for *x*-ray dosage, Muir's "A Manual of Practical *x*-Ray Work," and Cohn's "Normal Bones and Joints," with a Foreword by Dr. Rudolph Matas. There will also be an advance showing of Osgood's "Teeth and Jaws," and William H. Stewart's "Skull Fractures," and the usual general line of *x*-ray literature.

9. In Booth 13 the uses and advantages of "Horlick's," the original malted milk for *x*-ray work will be interestingly presented, and the representative in attendance will demonstrate the new Dumore Electric Mixer, Model No. 6, which greatly facilitates the preparation of Horlick's Malted Milk and barium sulphate as a suspension medium in *x*-ray diagnosis.

10. The Patterson Screen Company will demonstrate the Patterson Foreign Body Fluoroscope in addition to the well-known Patterson Cleanable Intensifying and Fluoroscopic Screens. The Patterson Foreign Body Fluoroscope was developed to assist the roentgenologist in the removal of foreign bodies on the fluoroscopic table.

11. The Radium Chemical Company of Pittsburgh will exhibit instruments for the handling of radium element in tubes and needles, and radon (radium emanation) in implants, tubes, needles, local packs, etc. Technical and clinical experts will be in attendance to demonstrate instruments and to discuss the various problems connected with radium work. Operators and all others interested in radium and radon work will find it profitable to visit this exhibit.

12. The Radium Emanation Corporation will have a most interesting display, showing an actual working model of the Duane Emanation Apparatus used for the collection of radium emanation—radon.

13. The Standard *X*-Ray Company will exhibit its double disc, ionized air chamber high tension rectifier, which is being offered to the medical profession as a serviceable unit, capable of generating roentgen rays to cover all demands of technique. They will also exhibit the Two-way Combination Tilt Table for stomach work, and other roentgen-ray machinery and apparatus.

14. The Victor *X*-ray Corporation will exhibit the Snook Special *X*-ray Transformer, the new water cooling system for the 30 ma. Coolidge tube for deep therapy, and their well-known line of other *x*-ray equipment. They will also have a complete line of physiotherapy apparatus, including as a feature the new Victor quartz lamp equipment.

15. The Waite and Bartlett Manufacturing Company will show the oil immersed dental and 4½ in. oil immersed unit mounted on a counter-balanced tube stand, an oil immersed unit with a special headrest for the Witherbee Tonsil Treatment and the Hickey Oil Immersed Fracture Table.

16. The Wappler Electric Company will demonstrate the Endotherm, or Radio Knife machine, and the Wappler flat Bucky table. Their new Seven Inch Vertex machine will also be on exhibition.

17. The Weinig *X*-Ray Company will exhibit a full line of Standard *x*-ray apparatus and accessories. Heretofore Standard apparatus has not been widely introduced in the east although it has enjoyed tremendous popularity throughout the west. Their equipment will be the latest type of *X*-ray transformers, bedside units and deep therapy apparatus.

INTERNATIONAL CONGRESS OF RADIOLOGY, LONDON, 1925

Our English confreres propose to call an International Congress in Radiology for the early part of July, 1925, to be held in London. The tentative program contemplates that three days be devoted to the reading of papers and three days to the visiting of hospitals in London, and that other radiological centers like Liverpool, Manchester, Edinburgh, Glasgow and the universities of Oxford and Cambridge be visited. This, together with sight-seeing, will consume approximately three weeks, so that the trip to England, the sojourn there and the return trip to the United States ought to take, depending upon the speed of the steamer, from five to six weeks.

It has occurred to several American radiologists that while the trip to England is made, we might with great profit extend our trip to the Continent, visiting France, Germany and Austria, ending with a visit to Stockholm, which is today, thanks to the genius of Dr. Forssell, one of the great radiological centers of the world.

With this object in view, inquiries were made of several of the great touring agencies, with the following result:

Provided the party has a minimum number of 60, and the travel is on the one-class cabin steamers instead of on the luxurious liners, and the traveling abroad is done in second-class railway carriages (third-class or auto buses for England) the following rates are given:

New York to London; 7 days in London; 1 day at Oxford; 1 day at Cambridge; 1 day at Manchester; 1 day at Liverpool; 1 day at Edinburgh; and 1 day at Glasgow, with some sight-seeing through the picturesque parts of England, particularly the so-called Shakespeare country, and return to the United States: the cost per person will be approximately $575–$595.

If the itinerary is to include France, visiting the radiological institutes of Paris as well as sight-seeing, and visiting parts of France, particularly the battlefields, devoting approximately two weeks to that, the cost will be increased by $175 to $235 meaning a total of $750–$830.

If the trip is to be extended farther on the Continent, visiting Frankfurt, Freiburg, Munich, Erlangen, Vienna and returning by way of Prague, Dresden, Berlin to Hamburg, the cost will be increased by $245–$260 making a total of $995–$1090.

If, however, we are to go to Stockholm and from there home, the cost will be increased by from $180–$230 making a total of $1175–$1320.

One of the touring agencies states that the approximate figures submitted include the following:

"The exclusive services of an experienced and capable Tour Manager, who will devote his entire time to the welfare of the parties. He will be assisted wherever necessary by fully qualified local guides.

"Stateroom, berth, and meals on Trans-Atlantic liners to the value of $275 including war tax, railway transportation in Europe, 3rd class in England, 2nd class on the Continent, 1st class on all local steamers, including the Channel boats.

"Hotel accommodations *without* private bath. The latter can be arranged for by individuals desiring it at extra cost.

"Three meals a day everywhere. When traveling or sight-seeing, meals include those served in the dining-car or any suitable restaurant. (Wines or other beverages are not included.)

"Comprehensive sight-seeing trips at each place visited. All local taxes paid. Tips and fees to hotel servants, porters, etc., also on sight-seeing trips while with tour manager.

"Transfer of passengers and baggage between railroad stations, piers and hotels. 100 lb. free baggage allowance."

The following items are not included: Tips to stewards on Trans-Atlantic liners; wines, liquors, beers, mineral waters and other beverages; laundry and expenses of passport and visas. (The tourist company will, however, obtain the necessary visas after the passport has been secured.) Sight-seeing other than specified as included in the itinerary.

In order to obtain proper accommodations it is necessary to inform the touring agencies as soon as possible of the number intending to take the trip and of the decision regarding the itinerary. They were promised that early in September the final decision will be reached.

Now is the time to make up your mind to take the trip next year and whether you will do so alone or accompanied by your family. Members of the American Roentgen Ray Society and of the Radiological Society of North America are allowed to invite guests who need not necessarily be physicians.

To start the ball rolling, it is suggested that those desiring to take the trip or wishing to obtain information communicate as soon as possible with the undersigned at 27 East 95th Street, New York City.

L. JACHES.
Chairman of Committees.

FIFTEENTH CONVENTION OF THE GERMAN ROENTGEN SOCIETY HELD IN BERLIN, APRIL 27 TO 29, 1924

Prof. Wintz, president of the Society, opened the meeting and greeted the members who had come from Germany, Austria and other countries. He pointed out that the subject of light-therapy was a new added field. In reviewing the accomplishments of roentgenology, he drew attention to the remarkable applications of roentgen rays in metallography and geology. The difficulty of research work with roentgen rays is well known. To advance the science of roentgenology, it is necessary to combine technique, physics and clinical observation. The practitioner as well as the research worker must be well acquainted in related fields of knowledge. It is the object of the German Roentgen Society to include all related subjects, to encourage their investigation and utilize their results.

The first day of the meeting was devoted to diagnosis. Koehler demonstrated a number of unusual roentgen findings: A case of duodenal ulcer with defect as in carcinoma; a case with serration on the smaller curvature; and separate roentgen pictures of a freak having tibias only 8 cm. long and abnormally twisted and broadened fibulas.

Haenisch reported an interesting and very rare finding in the roentgen diagnosis of the esophagus. A woman, 31 years old, had complained for some time of difficulty in swallowing, had been unable to take food for several months, and was in very poor condition. The stomach sound passed down smoothly, and no tumor was discoverable with the esophagoscope. The roentgenograms taken during the past 3 years revealed a slowly growing shadow developing in front of the spine which resembled somewhat a mediastinal tumor. Autopsy some time later disclosed a giant cylindrical fibroma (with a thin pedcicle attached at the entrance of the esophagus) hanging like a thick sausage and filling the esophagus to within a few centimeters of the cardia.

Haenisch also described a paresophageal hernia of the diaphragm, or esophageal diverticulum. Examination of the esophagus undertaken because of varying difficulty in deglutition showed a smooth passage, no dilatation and no cardiospasm. The stomach was normal. Roentgenoscopy in the supine position showed the esophagus suddenly filled, and there appeared immediately above the diaphragm, at its junction with the spine, a smoothly outlined shadow about the size of an apple. Between this and the fundus of the stomach there was a broad band. As soon as the patient returned to the erect position, the findings became normal.

Haudek discussed traction diverticulum of the esophagus. This is a frequent finding for the anatomist, but rare to the roentgenologist. These diverticula are of practical importance because they may suggest disease of the mediastinal glands. The typical picture shows the toothed appearance of the traction diverticulum, which becomes invisible after emptying of the esophagus.

Gortan reported on his technique for instantaneous and rapid roentgenography. Use is made of very hard, gas-filled tubes and good exposures of the thorax are obtained in 0.1 and 0.02 seconds. Holtzknecht called attention to statements that the ray-hardness ordinarily used for roentgenograms is not the ideal. There is some truth in this, and the physicist may furnish an explanation. Groedel believes that extreme loading of very hard tubes causes production of softer rays. Frik had made such tests with hot cathode tubes. Exposures to very hard tubes gave distinct pictures of matches, match-box and thin leaves, while much softer tubes did not.

Foerster described experiments to eliminate from view the small curvature of the stomach during swallowing. Roentyum-gelatine capsules swallowed while in the left recumbent position were observed to miss contact entirely with the smaller curvature. They sank to the left wall of the stomach, to the fundus and there remained at rest for some time. The antrum and smaller curvature, so important in gastric ulcer, remained undisturbed by small meals when swallowed in the left recumbent position. The position also favors mild stimulation of acid production and weak peristaltic waves, conditions advantageous in gastric ulcer. Practical results appear to bear out these observations.

Rahnenfuehrer compared the results of gastroscopy with those of roentgen examination. Over 200 gastroscopies were completed without accident. It is not yet possible to see clearly all portions of the gastric mucosa, so that it is unwise to stress a negative finding when made with the mirror. In chronic gastritis, gastroscopy is undoubtedly preferable to roentgen examination. It was often possible to differentiate between spastic and organic stenosis of the pylorus. Ulcers undiscovered by roentgen ray may be easily and definitely diagnosed by gastroscopy. It was often possible to follow the healing process of an ulcer; and in several cases gastroscopy permitted differentiation of extra-ventricular and stomach tumors. Haenisch pointed out the danger of comparing a good gastroscopy with a doubtful roentgen examination. Haudek mentioned the importance and necessity of gastroscopy in those cases where the roentgenogram cannot differentiate between ulcer and carcinoma. Gastroscopy has proven that disappearance of the recess indicates removal of the spasm but not of the ulcer.

Ratkoczi gave a summary of 2600 stomach examinations. In 80 per cent of the cases, he found the caudal pole below the umbilicus; and he has come to the conclusion that so-called ptotic troubles are due to poor tonus.

Hermann reported on pathologic-topographic relations between the stomach and intestine based on studies upon tuberculous individuals. Undiagnosed peritonitis was often found, or else local peritonitis which appeared to produce a fusion of stomach and intestine. The latter produces an interesting roentgen picture which has not been described.

Herrnheiser reported on the morphologic diagnosis of prepyloric and pyloric ulcer. Like other ulcers, these exhibit a circumscribed contour and alteration in form. The principles of Åkerlund's classical analy-

sis apply completely to the deformities in pyloric and prepyloric ulcer. The 4 fundamental types are: umbilication, contraction, retraction and formation of diverticulum. The reliability of the findings is fully as good as the morphologic diagnosis of ulcers in other locations. Combination of both varieties of ulcers occurs quite frequently.

Kahl reported a case of linitis plastica in a 10 year old child. There are 2 forms, one localized mainly at the pylorus, and another, generalized form of chronic inflammatory shrivelling of the stomach. The roentgenogram of the child showed a high-grade hour-glass stomach. The picture may very much resemble gastric scirrhus. After gastroenterostomy, the child's weight was doubled in 4 weeks.

Goetze observed in a case of duodenal ulcer, operated upon according to Billroth II, a recurrence within two years which demanded a re-laparotomy. This did not relieve and a new operation disclosed a deep seated duodenal ulcer necessitating resection down to the papilla duodeni. This ulcer was undoubtedly present before, and as a result of irritations was responsible for the recurrence.

Schinz regards cardiospasm as a symptom-complex. Hypertrophy was never found at operation. One should speak of the entrance to the stomach rather than of a cardiac sphincter. The condition is that of disturbance of the entrance mechanism, not of spasm; and the stretching during operation corrects the disturbance.

Goetze recommended roentgenographing the exposed kidneys in tuberculosis and renal calculus. The pelvis of the kidney is punctured, filled with sodium bromide solution and roentgenographed. The cavities filled with the contrast material become visible, and necrotic tissue becomes absorbed. This absorption is made visible by a subsequent insufflation with air.

Volkmann has sought by oral, rectal or intravenous administration to place a substance in the kidney which will produce a good roentgen shadow. Many substances were tried but none was completely satisfactory. Injection was made of sodium iodide, and the urinary system was roentgenographed 2½ hours later. The original Pregl solution is considered quite satisfactory for the direct filling of the bladder.

Gaebert demonstrated how in mitral failures the esophagus is pushed backward and to the right by the dilated left auricle. Examination of the esophagus is therefore recommended in the diagnosis of dilatation of the left auricle.

Weil discussed the diagnosis of the diaphragm. In one case, connective tissue bands in the lower lobe and in another case separation of the liver and diaphragm by air produced pictures resembling hernias of the diaphragm. Air may remain for quite a period between liver and diaphragm after pneumoperitoneum or pertubation and may introduce difficulties in the interpretation of roentgenograms. In addition, there was demonstrated a case of subphrenic protrusion of the stomach through an intercostal space beneath the skin at the side of the thorax. This case was long considered a lung hernia.

Grashey discussed spontaneous pneumothorax and spontaneous pneumoperitoneum. The latter is not very rare, a perforation may occur without causing peritonitis.

Jüngling demonstrated cases of ventriculography made by direct puncture of the ventricles. Lumbar filling is not considered advantageous. A roentgenogram taken in the lateral position is of slight importance. Tumors lying under the tentorium cerebelli may push it upward and reduce the size of the ventricles.

Ratkoczi recommended for the roentgen examination of the duodenum an extreme torsion to the right during compression of the pars descendens.

Klieneberger gave a demonstration of interesting cases, one being of congenital atresia of the ascending colon, and another, a case of tuberculosis causing calcifying abscesses in the pelvic region.

Altschul demonstrated his method of axial exposure of the patella. The roentgen tube is placed between the dorsum of the foot and the patella, and the plate at the distal end of the femur. Good pictures are obtained at 120° flexion, whereas other methods demand maximum flexion of the knee, which is often not possible. This technique revealed pathologic changes in arthritis

deformans and habitual luxation, in which front and lateral views were normal. Haenisch pointed out that good views are obtained of the patella in the dorso-ventral position with light rotation and manual luxation of the patella.

Kohlmann discussed postoperative bronchopneumonia and its relation to pulmonary infarct. Bronchopneumonia occurred just as often after splanchnic anesthesia as after general narcosis. It may be produced by embolism. Of importance is the fact that bronchopneumonias and infarcts are localized almost invariably in the right lung. Therapeutically, the strengthening of the diaphragm is important.

Kohlmann then demonstrated neurodystrophic changes of the osseous system in scleroderma and poliomyelitis. The hands of such patients show mushroom-like or snipped-off terminal phalanges. Plates were shown of the sacrum and coccyx taken after air-filling of the bladder; and these are claimed to be better than those taken after air-filling of the rectal ampulla. He also reported on a new, undescribed disease of the sterno-clavicular joint. The roentgen plate showed marked loss of substance of the medial end of the clavicle, and the epiphyseal line on the affected side was invisible. The clavicle appeared as if ground down. Operation disclosed a condition very much resembling Perthes' disease.

Haenisch showed a simple arrangement for the examination of duodenal ulcer, which permits making 4 exposures of the duodenal region on a single plate.

Vogt discussed 2 cases of calcified myoma and one case of large dermoid of the ovary showing pronounced calcification.

Schwarz spoke on the timely recognition of carcinoma of the colon by means of the roentgen ray. In a series of cases, the diagnosis of a high cancer of the colon was established by Haenisch's method of irrigoscopic examination, and prompt extirpation of the tumor resulted in permanent cure. This condition offers the best chances of cure if discovered in time, and the above method of examination should be utilized more than it has been in the past. Wall-like shadow edges indicate carcinoma. A tampon-tube is recommended for overcoming insufficiency of the anal sphincter while examining such cases. Haudek uses the same method of filling and examines the patient in the prone position on the trochoscope. The transverse colon becomes well filled in this position.

Mannl demonstrated a new frontal diaphragm for roentgen diagnosis. The diaphragm consists of a section of the eccentric portion of a fan wheel. Holtzknecht recommended this diaphragm which is more convenient than the Bucky diaphragm, and which can be centered by merely changing the inclination.

Frik demonstrated unusual aortic pictures. Case I presented calcification of the whole thoracic aorta. The edges of the aortic shadow are outlined by streaks of calcification. Case II was a spindle-shaped aneurysm of the calcified descending aorta. This case showed how a large portion of the descending aorta normally remains concealed in the heart shadow when examined in the first oblique position. Consequently, final judgment of a negative roentgen finding should be made with caution. Case III presented sinuosity of the descending aorta which must be considered a congenital deformity, since this waviness does not ordinarily occur because of fixation of the descending aorta to the vertebral column.

M. Fraenkel suggests inquiring before roentgenoscopy if the patient has recently undergone iodine, bromine or arsenic treatment; because burns occur more readily after such treatment. Radiation therapy may be enhanced by the simultaneous administration of specific substances having the property of increasing the radiation sensitivity.

The second day of the meeting was devoted to radiation therapy. Hans Küstner discussed the physical basis of dosimetry of roentgen rays with special regard to standard dosimetry. There is at present great confusion in the field of dosimetry. Many dosimeters are not sufficiently exact; and each dosimeter speaks its own language. A transportable standard dosimeter must be devised with which to compare all other instruments. The skin unit dose is inadequate as a unit; although a biological unit would be the logical one. The appropriate physical unit of energy

is as yet inapplicable. Friedrich's unit "e" is too much dependent on the material of the ionization chamber for physical purposes. The unit suggested by Behnken is satisfactory in that it is physically definable and measurable, and suitable for medical purposes. The spectral method is not suitable for standard measurement. The thimble chamber measures too little of the hard rays; but Behnken's compressed air chamber records the effect of practically all the ions. Ionization in the compressed air chamber at 8 atmospheres is dependent on the pressure; so that it is possible to standardize by this means. Behnken's unit is designated by the term "Roentgen" ("R"). The relations of this unit "R" to human tissues constitute a problem for the immediate future.

Holthusen spoke on the relations between physical and biological dosing. Since the mixture of wave-lengths used in practice will continue to be varied, agreement on the comparison at a certain wave-length is useless. Biological standardization is absolutely necessary, as the ionic dose decreases with increasing hardness. The biological activity of roentgen rays is considered as due to liberation of electrons; and transformation to heat and stimulation are doubtless also active. Quite different from the action of light, where the biological effect is entirely dependent on the wave-length, roentgen rays produce effects by their secondary rays as well as by their primary rays. Holthusen recommends his method of standardization by means of ascaris eggs as a biological method, utilizing the law of large numbers.

Friedrich discussed dosing in radium therapy. Other methods than those in roentgen dosing are required here because the object is too close and the radiation source emits a constant quantity of energy. Measurements made by a small ionization chamber or by biological experiments with beans or ascaris eggs are preferable to calculated values. The best form of radium holder is the spherical one; but where this is not advisable other shapes have to be used, having characteristic constants. Isodynamic curves were demonstrated. The variations in dosage are entirely dependent on the arrangement of the radium holder.

Miescher spoke on roentgen erythema. As a rule 3 successive waves of erythema result, rarely 2, and occasionally 4 waves. It appears that all histologic elements are involved in the erythema; and the fact that free nuclear division occurs during the successive erythemal waves is important. The cause of this succession is still hypothetical.

Keller discussed the action of ultraviolet rays on the skin with special regard to dosing.

Behnken discussed the standardization of dosimeters in absolute terms as performed at the Physikalisch-Technische Reichsanstalt, Berlin. The measuring equipment was described; and the pressure chamber and the precise measurement of an ionization current were demonstrated.

The German Roentgen Society voted unanimously to designate "One Roentgen" ("R") as the unit of measurement, and to use this henceforth in publications.

CARCINOMA THERAPY

Holtzknecht spoke on the roentgen therapy of carcinoma. This field is in a serious condition. Radical changes have taken place, unfortunately not for the better. Supposed progress has been imaginary because its basis was unsubstantial. The following views were erroneous: (1) that all carcinomas behave alike; (2) that small doses stimulate; (3) that 100 per cent of the skin unit dose is the destructive dose (instead, the tolerance dose must be known, and the latter is not the same in different spots). The whole method has failed, including the concept of homogeneity, and the clinical fact that of 100 operable carcinomas 10 are curable. Carcinoma of the uterus, thyroid, breast and rectum are amenable to roentgen therapy.

Two new lines for the advancement of the problem of cancer radiation present themselves. One utilizes the idea that cells in growing tissue are most sensitive at their period of maturation; and that during an irradiation only a fraction of the cancer cells are affected at any time. This suggests that two doses following each other in a very short time should produce better results. The difficulty lies in determining the correct interval. A suggestion for this may be found in the fact that no cell divi-

sions occur in the first three days following irradiation. The generally better results obtained with radium may perhaps be due to the longer duration of radium treatment and the consequently better chance of catching the cells during their period of susceptibility. Better results have also been obtained with successive doses in mouse experiments. It is a striking fact that in corresponding tumors the divided doses called for are not the same. A second line of progress is the suggestion of Opitz and Schinz to simultaneously irradiate surrounding tissue. These suggestions indicate the direction to be taken by future cancer therapy. Only experimental cancer research, not technique, will produce progress; and only from cancer pathology will a real cancer therapy be evolved.

Opitz spoke on the radiation biology of carcinoma. The assumption that the tumor cell is more sensitive than the surrounding connective tissue is not acceptable. In the animal, irradiation of a tumor is followed first by reaction of the connective tissue. Animal experiments show the existence of an optimal dose. The view that the treatment of cancer involves a physicotechnical problem is incorrect. Direct killing was not accomplished with the doses used. The body develops a reaction against the tumor, but it is not powerful enough. This must be strengthened by cautious irradiation. Biological reactions in man vary with the constitution.

Schinz discussing the same subject observed that tissues possessing a matrix are more sensitive than permanent tissues. The stage of mitosis is the most susceptible. Pathological, abnormal mitoses are demonstrable however after a few days. To study the effects, Schinz irradiated half of the malignant tumor several days before operation and later examined the radiated and unradiated tumor tissue. The growth of the cells was inhibited by the radiation; the number of cells was smaller although their size was the same as in the unradiated tissue. Consequently, in therapy he applies large doses (1.5 to 2 skin unit doses) only to small circumscribed skin tumors. In other cases, the effect on the tumor cell must be considered. Moreover there is danger of roentgen injury after strong irradiation.

THE GENERAL EFFECT OF RADIATION

Meyer discussed the subject of roentgen rays and metabolism. Protein broken down during roentgen irradiation is utilized in intermediary metabolism. The question is whether the organism utilizes this protein for cell construction or for sugar formation. In cancerous individuals there exists a demand of the tissues for sugar. Cancer tissue requires 70 times more sugar than does normal tissue. The results of research on the action of rays on cells are not great. The effects of rays on the fermentative processes should be studied and the changes in chemical composition of tissues should be determined. Meyer accepts the theory of Holthusen as to the origin of roentgen catarrh. Here, the protein material released by the rays produces reaction. Breakdown products from lecithin may likewise produce reactions.

Wels reported on a study of the roentgen effect on colloids. Colloid-chemical research is a connecting link between the physics and biology of radiation. The direct effects of the rays were discussed.

Kestner referred to the effect of rays (sun and artificial) upon man. Oxygen utilization increases as a result of the effect of altitude sun rays. The same result was also found after the application of skin irritants (stimulants) like cold or mustard baths. Warmth on the other hand decreases the metabolism. Therapeutically, the outstanding effect of radiation is a stimulation of the organism.

Pincussen discussed the effect of radiation on metabolic processes. Sunlight, quartz lamp light, arc light and intense filament light all produce marked effects on fermentative processes. The most powerful effect was found after irradiation with red sensitized light. Therapeutic experiments should be made on gouty and diabetic individuals.

Rothmann reported on metabolism studies. Light-baths cause a decline in sympathetic tonus and a permanent rise in the calcium level. Therapeutically, this sympathetic hypotonicity may be of importance.

Strauss reported on the effect of rays on the vegetative nervous system. The blood pressure of the rabbits was measured after insertion of a cannula in the aorta. After irradiation there was a decline in blood pressure which did not take place if atropin was previously given. A portion of the skin was underlaid with lead and irradiated. The result was again a drop in blood pressure. It is concluded from this that the control of the drop in blood pressure lies in the parasympathetic system. The effect was increased after insulin injection and irradiation. Irradiation of the dog after exposure of the pancreas and liver caused a rise in blood sugar, which disappeared when the adrenals were extirpated. It appears that the adrenal gland has an effect on the vegetative nervous system.

Friedrich has determined that scattered radiation is softer than the corresponding primary radiation. Phenomena of secondary radiation have an important bearing on therapeusis. The harder the rays, the stronger is the effect of the secondary radiation.

Schwarz discussed his biological and histological studies on tumors receiving divided doses of rays. He had pointed out in 1914 that there was an increase in cellular sensitivity during mitosis, and he has since accumulated much data. In sarcomas and lymphogranulomas, divided doses 10 days apart were found suitable. In carcinomas, this distribution of doses is no more advantageous than the 3-day interval. Histological investigations disclosed a great increase in mitosis during the stage of early reaction (increased blood supply while cell destruction had not yet set in). Schwarz therefore applies a relatively large dose during the first irradiation to produce an adequate early reaction, and then finishes with the remainder of the treatment on the 2 following days. This procedure was illustrated by figures and photographs. A repetition of the treatment after 6 to 8 weeks is permissible.

Jüngling discussed the latency and cumulativeness of roentgen rays. Instead of latency, it might be better to speak of the interval up to and between manifest phases of the reaction process. This distinction is important because a latency of roentgen effect, in the true sense, actually exists, namely when a latent stage of cell life is irradiated, as may be beautifully demonstrated with seeds. In that case, the reaction does not set in until the initiation of metabolic, mainly anabolic, activity. A characteristic of true latency is that a partition of the dose during this stage has no weakening effect, that is partial doses administered at intervals of weeks and months during the latent period are completely cumulative. These experiments explain to some extent the good results obtained with partial doses in the prophylactic irradiation of postoperative mammary carcinoma.

Theilhaber discussed the relations between immunity and carcinoma. The lymphocytes are the agents utilized by nature to cure cancer. They penetrate the cancer cell nests and cancer alveoli, break up the cell groups, surround single cells, often enter the individual cell, cause vacuolar degeneration and breakdown of protoplasm and nucleus. In the cancerous disposition there is, in addition to a local deficiency, also a general deficiency of lymphocytes due to hypofunction and atrophy of the lymphocytic organs. In the treatment of cancer, attention should be paid to the elimination of the local and general conditions favoring the production of cancer, i.e., to improve the inadequate cellular immunity, to increase the lymphocytes. For this purpose, injections of thymus and spleen extracts are effective. Transplantation of healthy pieces of extirpated lymphocytic organs would presumably be helpful also. A desirable means for increasing cellular immunity is the application of the various forms of electromagnetic waves, especially the short-waved roentgen rays and the long-waved diathermy currents. However, large roentgen-ray doses reduce cellular immunity practically to extinction, which may favor recurrence after removal of a cancer. Venesection and dermatitis caused by air- and sun-baths, are capable of combatting cancer and preventing recurrence.

Fürst, by using a combination of thick filter distant field (over 1 mm. Cu and 60 cm. skin distance), was able to eliminate

erythema and to obtain only a skin infiltration.

Lehmann, during 1920, applied in prophylactic irradiation of mammary carcinoma the full carcinoma dose and found as many recurrences as in cases not irradiated. Fewer recurrences were found in the first 3 years following irradiation with distributed doses, but after that there were more recurrences than in unradiated cases. The radiation therefore produced only a temporary delay in redevelopment of the carcinoma.

Hirsch stated that a local carcinoma cannot be influenced through the hypophysis.

Holzknecht, concluding this part of the discussion stated that only skin carcinomas should be intensively irradiated at the first dose, and that other carcinomas should be differently treated. One way to increase the number of mitoses artificially, may possibly be found in the fact that the fasting state in salamanders is accompanied by increased mitoses.

Braun reported on results with the thick filter method, using 3 mm. Zn. In deeply situated tumors the results are the same, but for superficial tumors the thick filter method is better. General injury was slight because the dose was kept below the skin unit dose and was divided over five days. The focus distance was 30 cm., and the time of irradiation through the thick filter was about 10 times longer.

Lahm reported on the results of the combined radium-roentgen-ray treatment of carcinoma of the uterus in comparison with simple radium treatment. The statistical review shows that 35 per cent of the cases were lost track of; 30 per cent died in the course of 3 years and 35 per cent are temporarily cured, i.e., after 2½ to 3 years' observation. This summary includes all carcinomas, operable and inoperable. The number, 35 per cent, corresponds almost exactly with that given by Kehrer in 1920 for results after treatment with radium alone. However, this is considered a step in advance because among the 34 cured cases at least 50 per cent belonged to Group III which Kehrer found showed only 20 per cent cure after 2 to 3 years. Additional treatment with roentgen rays therefore improved the results as a whole.

Hohlfelder pointed out that local radiation therapy of cancer is the most important. Because of the early reaction, the dose is administered over a period of several days instead of all in one day. Large distant fields are no longer treated. In the radiation of the trunk, for instance, three fields are taken and so centered that the radiation spheres miss each other. The rest of the tissues are thus protected. For the same reason, 2 distant fields are applied on 2 sides in cases where the cancer is eccentrically located.

Vogt furnished further evidence of the general effects of roentgen rays, which, according to experimental and clinical observations should be more often taken into account. Holtermann's experiments are cited in which white mice were sensitized to roentgen rays by vital strains. The effects observed were due to a general effect of the rays. The clinical observations are of still greater importance. Development of amenorrhea may follow the irradiation of a distant portion of the body, as in tuberculosis of the spine or lymphomas of the neck. Irradiation of the ovaries may induce cessation of growth of mammary carcinoma, or even recovery. The different behavior of ovarial cystomas toward radiation, contraction at first and later growth, points definitely toward a general effect of roentgen radiation.

Bacmeister reported successful results in combined surgical and radiation therapy of pulmonary tuberculosis. In advanced cases phrenicotomy was first performed, and then roentgen therapy applied. Cases were described which after this treatment showed a halt in the advance of the disease. This method is tried before pneumothorax treatment, of course only in unilateral cases. In acute cases, thoracoplasty followed by roentgen therapy yielded good results. Numerous plates were demonstrated showing the lungs in different stages of treatment.

Chantraine discussed the different radiation sensitiveness of the various tissues as dependent on their growth tendency. A cell is more radiation-sensitive the nearer its average activity lies to the maximum;

and it is non-sensitive the further its average activity is away from the maximum.

David reported studies of the effect of roentgen rays on the metabolic processes in the dog. Hypoglycemia always followed as a result of irradiation; but this result was absent if the splanchnic connection with the adrenals was destroyed.

Köpchen reported extensive studies on the action of roentgen rays on the chemical composition of the blood. The experiments lead to the conclusion that the changes in composition of the blood represent the general effect of the radiation.

Gabriel reported studies in rabbits on the effects of roentgen rays on the blood vessels. Irradiation of the kidney was followed by early signs of contracted kidney.

ROENTGEN INJURIES

Groedel discussed professional opinions regarding roentgen-ray injuries. In 75 cases of injury, 14 occurred through accident, 21 through carelessness and 40 through ignorance. Legally defined regulations should be established for purposes of guidance.

ROENTGEN RAYS IN INFLAMMATIONS

Pordes reported favorable results with roentgen therapy of inflammations. In numerous inflammatory diseases, the cell-depressing mechanism of the radiation acts favorably in the breakdown of the leucocytes produced in excess. Inflammations in dental conditions also react satisfactorily.

Fried set forth the effects of small roentgen-ray doses in tuberculosis, lymphogranulomatosis, leucemia and especially in inflammations and suppurations. The effectiveness of small doses is a fundamental phenomenon in inflammatory conditions. In the irradiation of surgical tuberculosis, the best results were obtained with 20 per cent of the skin unit dose. The same dose was used in inflammations. The radiation was filtered through zinc and occasionally through 5 mm. Al. Kausch and Jüngling voiced the fear that radiation might be applied without indications and that patients might suffer thereby. Wintz called attention to the fact that he had always obtained good results with the roentgen therapy of salpingitis. Holtzknecht mentioned the great impression made a few days previously at the Surgical Congress by reports on the radiation therapy of inflammations, and spoke of it as a new phase of roentgenotherapy. Even acute inflammations may be successfully irradiated. The progress of the inflammatory process often ceased almost instantly; and action interfering with or injuring function became unnecessary. There were few failures. The mechanism of the curative effect is a matter of speculation.

ROENTGENOLOGIC TECHNIQUE

Glocker discussed the physical bases and principles of construction of roentgen apparatus. Variations in radiation composition in the induction apparatus may be determined by means of a plate falling in front of the slit. The difference between the curve from the inductor and from the rectifier is of no significance in deep therapy. Electron tubes like the Coolidge type furnish, through filters, the same radiation for deep therapy. Without filtration and at low tension, the gas-filled tube is more homogeneous.

Grossmann discussed new tendencies in the technique of roentgen apparatus, comparing the new and old systems. Since surface dose increases with potential, the tendency has been to raise the tension. The features of a new apparatus called the Stabilivolt were described. The apparatus acts by doubling the tension. Its potential remains constant; and movable parts and spark gaps are absent. Instead of a transformer, this apparatus is an energy accumulator.

Voltz reported results in 500 cases irradiated with the Stabilivolt. The convenience and noiselessness of the apparatus were pointed out. Under conditions of ordinary usage, wear on the valve-tube is slight. The tubes remain well preserved; only 2 tubes being required for the 500 cases. A skin unit dose was obtained through 0.5 mm. Cu at 23 cm. skin focal distance, 2.5 ma. 250 kv. in 12 minutes.

Wintz reported securing results with such small doses of radium which were entirely out of comparison with usual

roentgen-ray doses. Wintz does not believe that the highest attainable tension limit has been reached. Increase in intensity is necessary for reducing the time of exposure; but the time of exposure must not be too small as the results then will not be any better. Increase of the tension above 250 kv. is unnecessary and dangerous. Gas filled tubes are of advantage in certain problems of therapy and diagnosis.

Baumeister reported on a simple method for measuring fluorescence and scattered radiation. Measurements were made with the iontoquantimeter on a wax form 20 cm. long, bored in the center to admit the measuring chamber, and divided into 4 parts by diametric sections. It was found that the measuring chamber received the greatest increment of scattered radiation from the front, and the least from behind. In another experiment the chamber was arranged to receive only scattered radiation from three different directions. The intensity of the radiation was greatest toward the primary rays and least away from them. It follows therefore that a deep organ will receive the largest increment of scattered radiation on the side facing the primary rays, and the least at the back. Further experiments showed that the more penetrating the primary radiation (that is, the smaller the proportion of soft radiation, as in filtration) the greater is the percentage increase of scattered radiation from behind, which is of advantage in deep therapy.

When a skin area 24 cm. square irradiated at 30 cm. focal skin distance is found to show an intensity of 100 per cent in the center and only 86 per cent at the edge, the maximum at the center is not due to a scattered radiation increment, but rather to the fact that the focal distance at the center is 30 cm., and at the edge 32.3 cm. Comparative measurements showed that scattered radiation is less penetrating than primary radiation. It was determined that measurement of the dose was somewhat too low because of the measuring chamber carrier. The deep dose as measured by the iontoquantimeter (at 10 cm. depth) is 10 per cent too high; thus, a dose of 20 per cent would be read 22 per cent.

The fluorescent radiation emitted by metals was measured with the iontoquantimeter. The wave lengths of the different elements are simply related to their atomic number in the periodic system. The radiation intensity is increased 3.5 times by the fluorescence radiation of copper. This is of importance in the "coppering" method of Wintz. In "coppered" tissue, fluorescent radiation can be induced which is of great effect. Copper molecules lying at the surface of a cell may emit a radiation that might even reach the nucleus. However, this fluorescent radiation can be filtered out by 1 mm. Al.

Seemann reviewed with the aid of pictures and models the development of roentgen ray spectral apparatus, with special respect to their utility for hard therapy radiation. While the classical spectrographs, because of the arrangement of the analyzing crystal between the slit and the photographic plate could yield only blurred spectra of hard rays (because the latter are reflected not from the crystal surface alone, but also from a considerable depth within the crystal), the hole camera method of Seemann or the window method of Friedrich and Seemann yield perfectly clear spectra in spite of volume reflection. This is accomplished by placing the crystal between the roentgen tube and slit, i.e., outside of the spectrograph camera proper. The subjective reading of the minimum wave length on the screen is uncertain.

Gyemant described a new principle for the quantitative measurement of any radiation causing fluorescence. The method utilizes the so-called variously concentrated screens. The active material is mixed in certain proportions with an inactive one whose absorptive properties must however be very similar to those of the active material. An example is calcined and uncalcined calcium tungstate. To compare 2 different intensities, two screens are selected which give the same brightness. The measurement of the intensity of a source of radiation is made by comparison with a standardized screen. The mixture value is in this case the exact measure of the intensity. The hardness of the roentgen rays is measured by introducing an absorp-

tion wedge in front of a 100 per cent screen until the brightness of this screen is reduced to that of a 50 per cent screen. Wintz remarked that he had some time previously discussed the principle of this procedure.

Dieterich reported on iontoquantimetric measurements on the water phantom standardized according to the Freiburg system.

Daumann reported on the simplex valve of Firma Müller, Hamburg, which operates on the well-known principle of one sided conductivity of an incandescent cathode in a very high vacuum tube. The present valve has satisfactory durability and sufficient tension trustworthiness. A large number of tubes burned longer than 1000 hours. The valve may be used for running roentgen tubes directly from a transformer, or for the charging of condensers and the production of direct current. A special rheostat transformer must be used with the tube.

Special tubes with the Lindemann-window were constructed for the investigation of materials. It was thus possible to obtain the intrinsic radiation of even light anticathode metals (for instance the K-radiation of Cu and Fe) from a sealed tube. By means of suitable filters, it is easily possible to make the radiation strictly monochromatic. For other aspects of the investigations of materials there were constructed tubes whose hardness approached those of therapy tubes.

Lahm demonstrated a new radiation apparatus for deep therapy which permits exact centering of the radiation. A spherical segment is erected over the point to be centered upon. The tube is arranged to move over this spherical segment so that the central ray is always directed at the point.

Beyerlein demonstrated a covered therapy frame for high potential work, which permits exact adjustment of direction and satisfactory fitting.

Engelbrecht showed a picture of a radiation-proof compression stand. The tube is located in a large, tightly-closed, radiation proof, cylindrical box from which the heated air during operation is forced out.

Gabriel demonstrated a film roll casette which permits the taking of serial or single exposures during roentgenoscopy. Any section of the body may be accurately brought to focus under direct control of the eye.

Hoffmann reported on a roentgen tube which produces 20 ma. at a potential of 250 kv.

In conjunction with the meetings, the following films were shown: (1) " Roentgen Film" showed in the form of animated pictures the generation of roentgen rays. (2) "Roentgen Irradiation of Mammary Carcinoma" showed all the technical details.

G. F. Haenisch.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

THE ROTATING SPIRAL IN ROENTGENOGRAPHY

BY HAROLD S. SAWFORD

NEW YORK CITY

IN the September, 1923, issue of this journal, I gave a brief description of a flat disk, constructed of cork and ribbons of lead in spiral form, for filtering out scattered radiation in roentgenography.[1] These strips of lead are arranged at angles which gradually vary with relation to a predetermined distance of the tube target to the center of this disk. The disk revolves inside a track and is driven by a small motor, using an endless belt. I would like to describe, in further detail, some of the methods which have been used in the construction of this disk, and report some further findings.

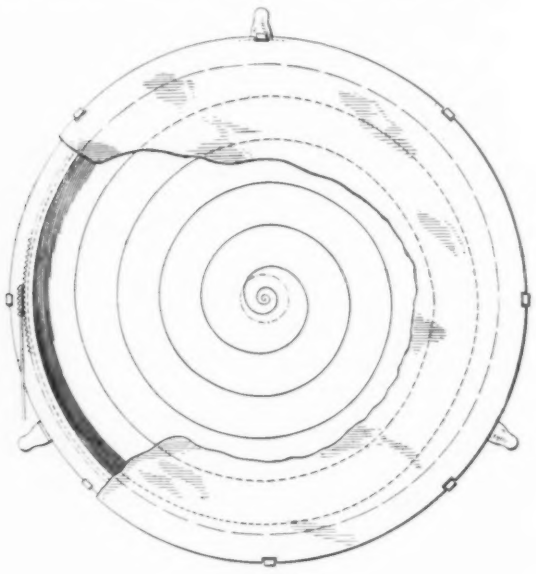

Fig. 1

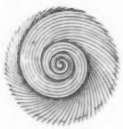

Fig. 2

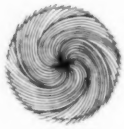

Fig. 3

FIG. 1. Shows approximate amount of flare necessary for a disk 22 in. in diameter.
FIGS. 2 and 3. Showing two methods of constructing the central portion of the disk.

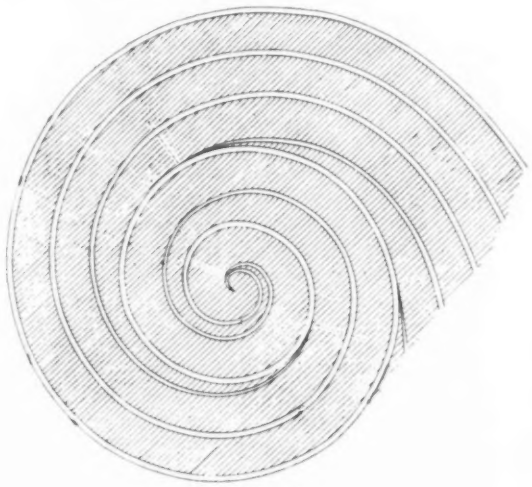

Fig. 4

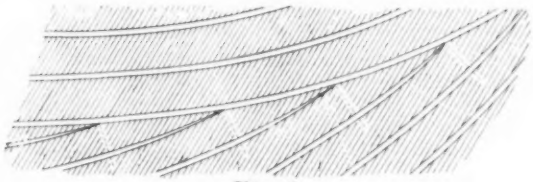

Fig. 5

FIGS. 4 and 5. Greatly enlarged view of the center portion of the disk and a section nearer the periphery of the small circle.

It was noted that a number of ribbons was necessary, in the construction of these disks. This was the outcome of the realization that if one, or a few, narrow spaced strips were used it became very difficult to accurately adjust the convolutions to their respective distances from

[1] Sawford, H. S. Flat diaphragm of spiral design in roentgenography. AM. J. ROENTGENOL. & RAD. THERA V, 1923, X, 737–738.

the center. Theoretically, every portion of each convolution should be at a different radial distance from the central point, but what actually happens is that considerable portions of each convolution become the arc of a circle, which, of course, will show as concentric rings on the film. This is due to the unavoidable variation in this distance when packing the convolutions together.

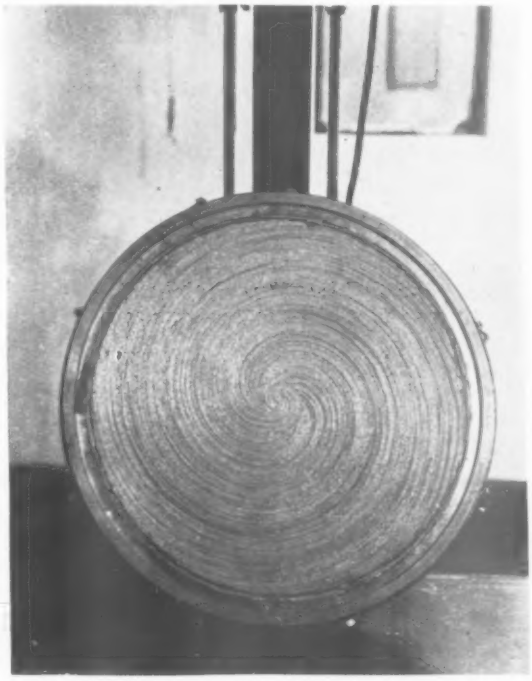

Fig. 6. Photograph of disk using 80 strips.

This difficulty, however, is easily overcome by increasing the flare. Figure 1 gives an approximate idea of the amount of flare that is necessary for a disk large enough to cover a $14'' \times 17''$ plate. This increase in flare does not in any way impair the high efficiency that is obtained by this type of grid. While it permits all portions of the convolutions to form a true involute, it is necessary, however, to increase the number of strips, since the ratio of spacing and depth must be preserved. If the depth of the disk is decreased by applying these principles the number of ribbons must be increased still further and so, comparatively, a large number of ribbons must be used.

Figures 2 and 3 show two of the many methods that have been tried in the construction of the central portion of the disk. It is obvious that many variations and combinations of these methods can be made. This central portion is constructed inside of a comparatively small circle, the diameter of which is determined by the number and spacing of strips, and around the periphery of which

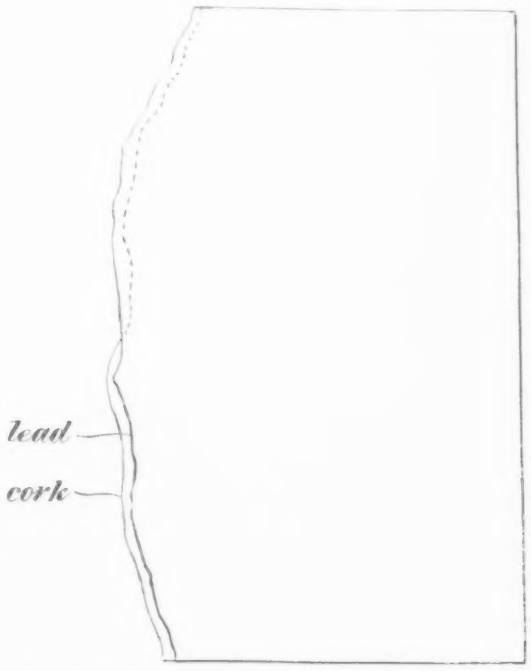

Fig. 7. Composite material sheet cork and lead.

a number of slender steel pins are fixed with one in the central point.

In Figure 2 the first ribbon is brought into this circle in the form of a volute spiral gradually diminishing its flare toward the center. The second is brought inside the first with the necessary spacing and runs parallel till it touches the convex surface of the first lead strip. In a like manner others are brought in, running parallel and touching the convex surface of the first lead strip, until the circle is filled.

Figures 4 and 5 show a greatly enlarged view of this central portion and a section near the periphery of the circle. It will be noted that there is a tapering of the

spacing between the ends. The lead ribbons are also tapered in proportion, terminating in a point. By this means the filtering efficiency is exactly the same in the central portion as in the remainder of the disk and, also, no two ends pass over the same path as the disk revolves. In using this method, it is necessary that the disk should run true and that there should be no play between the rotating member and the stationary track.

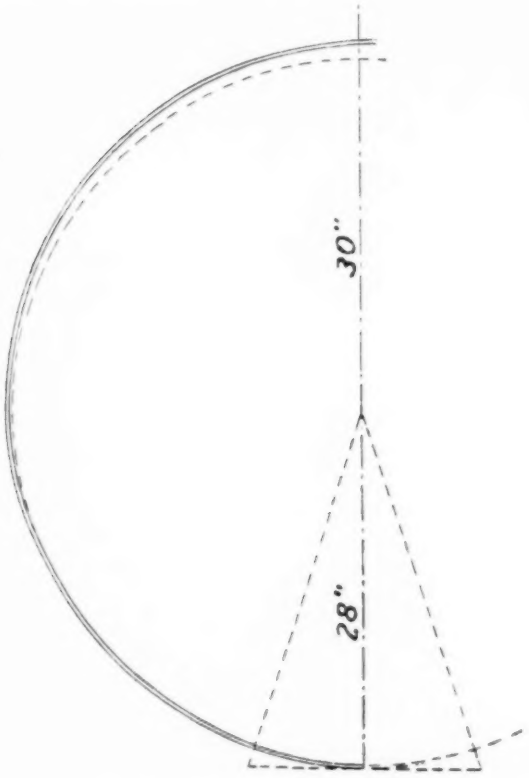

FIG. 8. Diagram showing method of cutting ribbon on involute curve, (slightly distorted).

It was found, however, that quite a number of these tapered ends could be brought to the central point without showing any disturbing shadows on the film. The methods described permit of a great number of strips being used. It was thought that some advantage might be gained, with relation to speed, by increasing the number still further. Figure 6 is a photograph of a disk using 80 strips. Eight of the tapered ends terminate very close to the central point and eight at slightly varying distances therefrom. The remaining 64 are arranged as previously described, this large number permits the use of slow speed and still allows a comparatively large number of strips to pass over the stationary film for all the variations of exposure. The slow speed is desirable as it reduces the danger from vibration and practically eliminates noise.

The lead used in $^{8}/_{1000}$ in. in thickness and the depth of the disk approximately $^{5}/_{16}$ in. The ratio of spacing to depth is approximately 2 to 11. It will be noted that there is an unnecessary increase of the flare of the convolutions, due to the large number of strips used. This flare and the depth can be reduced, of course, by decreasing the spacing and using a similar number of strips.

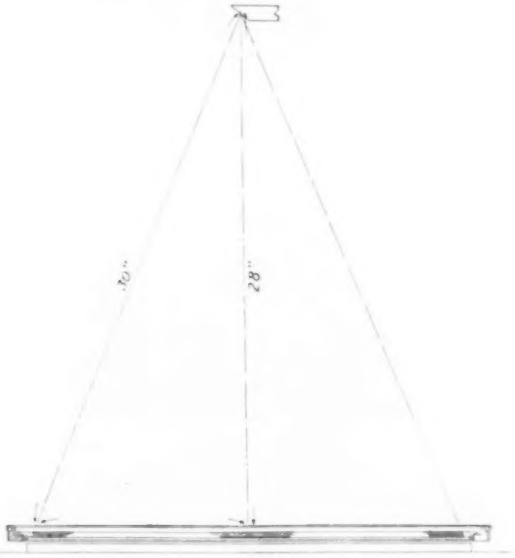

FIG. 9. Distances from tube target to the center and periphery of disk.

The complete obliteration of grid shadows obtained with the revolving spiral is undoubtedly due, in great part, to the fact that a speed can be chosen with relation to the impulses from the tube target and not to the variations in time of exposure. The number of impulses delivered from the tube target do not alter, are definite, and cast distinct shadows on the film. Where there is a limited excursion of the grid, the speed of travel must vary with the length of exposure, so it is not

surprising if a sequence is sometimes obtained. The rotating movement of the spiral grid also allows a comparatively large number of lead strips to pass over the stationary film.

FIG. 10. Photograph showing method of clamping cover on grid.

These features account for the ease with which complete obliteration of grid shadows is obtained on all exposures necessary in grid work. There is some latitude in the choice of speed. One revolution in 2 to 4 seconds gives excellent results for the longer exposures. For the shorter exposures the speed can be increased, care being taken that the lead strips do not move in synchronism with the impulses from the tube target.

The spacing material may be of cork, celluloid or similar material. Sheets are chosen with a thickness corresponding to the spacing desired. Sheet lead is fastened to this material by the aid of a heated iron, using rubber or shellac tissue to prevent warping. From these sheets of composite material (Fig. 7) ribbons are cut, using a width corresponding to the depth of the grid, of a predetermined length, and in the form of an involute curve, i.e.

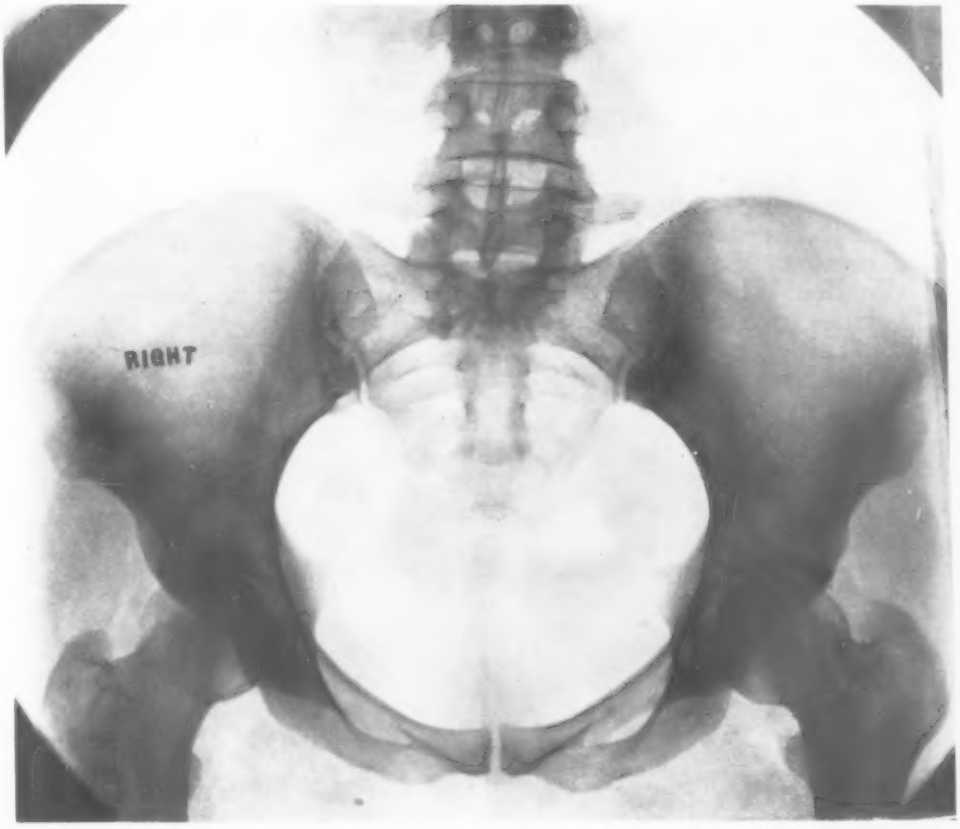

FIG. 11. The reproduction of roentgenogram for which the Nitroken tube was used.

with gradually increasing radii (Fig. 8). The ends of the strips that form the central portion correspond to a radius of, say, 28 inches (this is the distance from the tube target to the center of the disk). The radii gradually increase to 30 inches for the other end of the ribbons (this is the distance from the tube target to the periphery of the disk) (Fig. 9). The lead side of the strips will, of course, form the convex surface of the convolutions. When the ends are prepared for the center, small portions may be cut off to allow for the varying distances they are placed from the central point. When the central portion is built and the strips packed closely together, every portion of the convolutions will come to the precise angle required for that predetermined distance from the focal spot to the grid center. It is found in practice that for the ratio mentioned this distance may be varied 1 to 2 inches either way without materially affecting the length of the exposure.

The track and rotating member consist of two bronze rings turned in such a manner that one runs inside of the other. The endless belt was chosen as being somewhat simpler than the flexible shaft and worm drive and prevents the danger of transmitting vibration. The cover consists of sheet aluminum spun on a ring made of ¼ in. brass. This is riveted to give added strength. This cover fits snugly over the stationary ring and can be tightened by 8 small clamps (Fig. 10).

SUMMARY

The spiral type of grid possesses several distinct features, a combination of which apparently cannot be obtained by any other method.

1. It has a higher efficiency than straight strips of the same ratio.

2. The rotating movement gives a complete effacement of grid shadows with comparative ease of operation.

3. The time of exposure may be broken up if, and when desired.

4. The depth of a disk can be reduced to a minimum, being limited only by the proportionate amount of lead used.

The reproduction shown in Figure 11, is from a roentgenogram for which the Nitroken tube was used. It represents a patient of average thickness.

The writer desires gratefully to acknowledge the collaboration of Dr. C. H. Watson, and of Dr. H. G. Dunham.

NOTE. Attention is directed to the work of Åkerlund on the above subject:

Akerlund, A. Ueber Vorrichtungen zur Abblendung der Sekundärstrahlung bei der Röntgendiagnostik. *Acta radiol., Stockholm*, 1921–22, i, 480–486: Die spiralförmige Sekundärblende. *Acta radiol., Stockholm*, 1923, ii, 77–82. D. R. B.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

ATLAS TYPISCHER RÖNTGENBILDER. (Lehmanns Mediz. Atlanten, Band v). By Grashey. Vierte Auflage. Price, $4.70. Pp. 236, with 368 figures in the text, and 227 plates. München: J. F. Lehmann, 1923.

This work continues to be a treatise on the roentgenology of the normal skeletal system. The normal roentgenology of the uropoietic system and several encephalographic sketches are the only extensions of the scope. The title may be regarded as somewhat misleading because the atlas includes only normal roentgenograms.

A text of 91 pages presents a full introduction to roentgen-ray physics, types of apparatus and considerable detail of the technique of roentgen photography. Moreover, the principles of perspective and of orientation of roentgen shadows are discussed. There is a new section treating of nomenclature and of the interpretation of roentgenograms of children. An ossification table is given which should be hung up in the roentgen laboratory.

The main section, the atlas, presents 227 plates (autotypes of the normal human skeleton in the natural size). Pictures taken from unusual angles are also given. The numerous text illustrations explain and complement the plates. The different variations are completely presented. There are new pictures of the newborn and numerous illustrations of the growing osseous system. Roentgenograms are given, as well as the technique in taking them, of axial and lateral views of the scapula, sternum, symphysis and sacrum.

G. F. HAENISCH.

LEHRBUCH DER RÖNTGENDIAGNOSTIK. Herausgegeben von A. Schittenhelm. Band I and II. Paper. Price, $17.65. Pp. 1283, with 1032 illustrations and 3 tables. Berlin: Julius Springer, 1924.

During the last year two notable publications have appeared in German, first a book by Assmann which deservedly has met with a most favorable reception, and second, a book by Küpferle on "Tuberculosis of the Lungs." Recently there has appeared a notable addition to roentgen literature in "Lehrbuch der Röntgen-diagnostik," in two volumes, compiled by a number of prominent German roentgenologists. In the first volume there is an article by Kaestel of Munich, taking up the subject of roentgen physics and roentgen technique. While this is very admirably written, it naturally describes many of the types of European apparatus, the descriptions of some of which are interesting only from a historical standpoint. We were glad to note in this article the description of the Albers-Schönberg diaphragm which really was the prototype of most of the different types of tables in use at the present time. We regret that there is not a detailed description of the Potter-Bucky diaphragm which is now so universally used in this country.

The second article is by Schüller of Vienna, and is a most valuable contribution. We would especially note the chapters on hydrocephalus and brain tumor. The illustrations in this article are well worked out, with numerous expository diagrams. Schüller gives a good description of Dandy's work and the chapter concludes with a comprehensive bibliography which is valuable to anyone especially interested in the subject of roentgenography of the head.

Thost of Hamburg contributes an interesting chapter on roentgen examinations of the ear, nose, and throat. The chapter on the mastoids is perhaps somewhat disappointing. The descriptions and illustrations on the different diseases of the larynx, especially tuberculosis and carcinoma, are especially attractive.

The extensive investigation of the respiratory tract by Kaestel of Munich is well illustrated and takes up in detail both the acute and chronic diseases of the lungs. The bibliography is up to date and is apparently complete.

Rieder of Munich contributes an interesting section on the roentgen examination of pneumothorax, the pleura and the diaphragm. While the illustrations are diagrammatic, they are instructive. Of special moment is the table giving the points in the differential diagnosis, between hernia of the diaphragm and eventration of the diaphragm.

F. M. Groedel has written a detailed account of the roentgen examination of the circulatory system.

In the second volume, Schwarz of Vienna has written at considerable length on diseases of the esophagus. He considers the normal stomach in detail, and the special topics of gastric ulcer, and gastric carcinoma. The question of duodenal ulcer is also treated at considerable length. He also takes up the normal and pathologic colon. The illustrations

with this article are numerous and unusually clear.

Schittenhelm and Wels discuss the examination of the abdomen and its organs with the aid of pneumoperitoneum. In their work they make use of a special table which permits of exposures with the patient held in a great variety of positions. There is a special arrangement so that exposures can be made with the patient lying upon the side. The illustrations are numerous and well provided with explanatory legends. This article takes up also the special subject of pelvic pneumoperitoneum.

The subject of the examination of the genitourinary system is discussed by Schlecht of Duisburg. This article is copiously illustrated and the text appears complete. The bibliography, however, comprises only an index of articles found in German literature.

Bürger of Kiel and Schlecht of Duisburg discuss the roentgen findings in diseases of the endocrine glands. Various conditions of the hypophysis are illustrated by diagrams. The section on the thymus is rather incomplete. Of especial interest in this article are the roentgen studies on the development of the skeleton giving the variations seen in different endocrine disturbances.

Köhler of Wiesbaden has a very complete section on the roentgen diagnosis of bone and joint diseases. Perhaps the most valuable part of this chapter is the complete bibliography given under the separate headings of the various bone diseases.

A good general index of authors, references, and subject-matter completes the two volumes. This complete index will enable the book to be used as a reference handbook. The two volumes comprise an important addition to roentgen literature.

P. M. Hickey.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

EWING, JAMES. The influence of radiation therapy on the study of cancer. *Canadian Pract., Toronto*, March, 1924, xlix, 95–104.

The pathological processes in the two classes of tumors, embryonal and adult, are essentially different. This fact was hardly appreciated until revealed as an obstacle to radiation therapy. In the embryonal type, radiation seems to act by producing autolytic degeneration through direct action on the cells and blood vessels. Such tumors are highly radiosensitive as compared with normal tissues, and a curative result may be obtained without notable damage to normal structures. Unfortunately the majority of malignant tumors, and some of the most common and important, are not radiosensitive and do not respond to ideal radium therapy. They require the actual killing of tumor cells and often a caustic action.

A third group of cases includes tumors either so bulky, or so inaccessible, or so resistant that neither selective radiation nor caustic action can be successfully employed. Here, radiation therapy must remain content with restraining growth. This group includes mammary and other glandular carcinomas, osteogenetic sarcoma and neurosarcoma. Restraining of growth of tumors is quite an unsurgical conception; but it has found a definite place in practical therapy in relieving acute symptoms and prolonging life.

CARTER, L. J. Intestinal bands and intestinal adhesions—differential diagnosis and treatment—a plea for more accurate nomenclature. *Canad. M. Ass. J.*, March, 1924, xiv, 212–215.

Attention is called to the need of establishing a more accurate use of the terms "intestinal bands" and "intestinal adhesions." The diagnosis of these conditions lies entirely within the sphere of roentgenology. By no other means except by exploratory laparotomy can the conditions be determined. Bands and adhesions are distinctly pathological entities and are definitely capable of differentiation by the roentgenologist.

The method of examination must be by means of the barium enema and through the use of the roentgenoscope. Disappointment will result through any effort to discover any great number of bands or adhesions by the study of the roentgenogram of the barium-filled colon. The conditions seen in roentgenoscopy are not readily caught in the roentgenogram.

Diagnosis of colon band is made when the barium enema is seen to cease its progress, its forefront flatten out as against a solid wall, and then there is observed a thin stream of barium trickle through the center or on either edge and spread out and fill the colon proximal to the point of delay, finally even obliterating the site of obstruction.

The diagnosis of adhesions is a little more difficult. When one or more sections of colon are seen to resist filling, yet do slowly yield and fill up to nearly normal caliber, and when filled become quite immobile, one may be reasonably sure that there are pericolic adhesions to the abdominal wall or adjoining viscera.

WELS, P. On some effects of roentgen radiation. *Strablentherapie*, 1924, xvi, 617–655.

Further experiments on the effect of roentgen rays on proteins showed uniformly after 5 to 11 hours' irradiation, a decrease in the surface tension of serum, and of albumin and globulin fractions derived from serum. It was expected that the opposite, increase in surface tension would occur, since a primary characteristic of the radiation effect on proteins is an increase of aggregate formation. The surface tension lowering is accounted for by the acidification of protein solutions after irradiation. The acidity was measured and expressed as differences in pH value. It is possible that early erythema may be related to acid formation in the skin; and, roentgen catarrh and toxic effects may be the result of this radiation acidification. Experiments on the effect of roentgen rays upon the oxidative ability of *Staphylococcus aureus* showed that the growth inhibiting power of the rays is not due to an effect on the oxidative property. The fermentative ability of yeast also remained unaffected after exposure for many hours to unfiltered roentgen rays.

LORENZ, E., and RAJEWSKY, B. The absorption coefficient of water and aluminium for hard roentgen rays. *Strablentherapie*, 1924, xvi, 475–486.

As precautions against soft scattered radiation, the beam of roentgen rays was carefully screened in its pasage to the electroscope by 2 lead plates (4 cm. thick) and 3 stiff brass screens (each with a 1 cm. hole). Screening was also placed behind the measuring object. Cu and Al filters were used to homogenize the radiation, the thickness of these filters being varied until

the same absorption coefficient was found for 5, 10 and 15 cm. of water at the various maximum tensions from 152 to 202 kv. The quality of radiation and the absorption coefficient were determined with a Seemann spectrograph. Two series were measured with the Koch recording photometer.

It was found that at a tension of 152 kv., 2 ma., filter 0.5 mm. Cu and 1 mm. Al the absorption value behind 5, 10 and 15 cm. water was the same, namely 0.177. The filtered radiation could therefore be regarded as homogeneous. By means of the Planck-Einstein law (assuming its validity), it is possible to determine precisely the maximum tension at the tube for the field measured. The coefficients found for Al are smaller than those determined by the ordinary technique, the latter being affected by scattered radiation. The value used by Richtmeyer for the coefficient of scattering by Al was found too large, it should be $\lambda_a \leq 0.08$ A.

Holtzknecht, G., and Pordes, F. Trend of thought, natural laws and hypotheses regarding roentgen stimulation. *Strablentherapie*, 1924, xvi, 728–740.

The Arndt-Schultz principle is not a law but merely an idea; and it cannot serve as a substantial basis. The word stimulation should be eliminated from science. There is no such thing as a roentgen stimulation.

Compatible agents, such as are natural to the cells, have an indifferent (sub-minimal) dose, *i.e.*, a dose administrable indefinitely at certain intervals; while incompatible agents have not. Roentgen radiation is therefore a cell-inadequate agent. The slight structural alteration of the cell produced by roentgen radiation acts as a relay—a small disturbing force influencing the action of greater forces. Direct acceleration of function or of growth by roentgen rays is therefore improbable.

Nishikawa, Y. The roentgenologic demonstration of the venous channels of the head. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1924, xxxi, 598–608.

Abnormally deep clefts of the sinus longitudinalis and lateralis are usually found in craniostenosis, especially in tower skulls. When the sinus sphenoparietalis is wider than 1 mm., it is evidence of disturbance of blood drainage. Local cause of such disturbance is usually tumor at the base of the brain.

The Pacchionian depressions are usually much enlarged in cranial hyper-pressure. Of the emissaria, the emissarium mastoideum is practically the only one of note roentgenologically, and various pathologic forms are shown. The venae diploeticae may also be demonstrated roentgenologically. The following types may be distinguished: netlike, branched, coralloid, vermiculate and stellate. Widening of the lacunae is also found. Knowledge of their roentgen pictures is important in diagnosing cranial defects, fissures and arterial branches in racemose aneurysm. General dilatation of the diploic veins is usually found in general cranial hyper-pressure; and in tumor and epilepsy the dilatation is unilateral. Syphilitic osteoporosis of the cranium gives a picture resembling the network of the diploic venous channels.

Biermer, L. Roentgen irradiation of ptyalismus gravidarum. *Med. Klinik*, Feb. 24, 1924, xx, 243–244.

Observation of a cure of parotid fistulas with roentgen rays suggested similar treatment of a case of severe ptyalism during pregnancy. Neither atropin nor psychic influence had any effect on the salivation. After vigorous irradiation of both cheeks with heavily filtered rays, the salivation ceased at once, and 14 days later returned to normal. A slight, unpleasant, stale taste still remained after 3 months.

Stone, William S. Treatment of Hodgkin's disease by the x-ray and radium based upon a study of 200 cases. *Canadian Pract., Toronto*, March, 1924, xlix, 109–116.

In the treatment of Hodgkin's disease roentgen-ray and radium therapy are only palliative agents. Palliation can be accomplished in about 60 per cent of cases; and full restoration of health with or without complete regression of the tumors may occur in about 32 per cent. Restored health will often last a year, and rarely 2, 3 or 4 years. Palliation will set in after the first or second treatment, if it is to occur at all. In general, the prolongation of life is about one or two years.

Piccaluga, Nino. The effect of roentgen rays on the reducing action of normal tissue and of neoplasms. *Strablentherapie*, 1924, xvi, 245–276.

The organism reacts *in toto* to roentgen rays; but the question is whether the general reaction is the principal factor or merely secondary. The methylene blue method was used as a measure of the respiratory activity of the tissues studied. It was found that when the cells became stained and did not decolorize the solution, the tumors usually failed to grow on transplantation. The tumors reduce methylene blue as long as they are viable.

Human tumors after intensive irradiation retained their power to reduce methylene blue.

This power is variable and does not permit quantitative comparison. *In vitro* experiments were therefore tried with excised human and animal tumors; and it was then found that changes in the reducing power were proportional to the doses applied. Doses of 200 to 300 per cent completely destroyed the reducing power. These experiments showed that the roentgen rays acted directly on the cell function, and that with small doses this cell function was stimulated in all organs. It was not possible to establish an exact basis for differentiating the effect of various radiation doses upon the tumor cells. It appears clear that present customary doses (sarcoma as well as carcinoma doses) are much too small to cause death of the tumor cells; because such doses were found to induce stimulation instead of inhibition of the reducing power.

In normal tissue cells, the changes produced were proportional to the applied radiation. At first there was stimulation and then inhibition.

OCHSNER, A. J. Clinical observations in the treatment of cancer of the uterus. *Canadian Pract., Toronto,* March, 1924, xlix, 104–108.

A change has been made in the former practice of surgical intervention to treatment with radium and roentgen radiation of all cases of cancer of the uterus, with very satisfactory clinical results. A number of patients have remained well for 3 years or longer, who would certainly have died within 2 years if subjected to hysterectomy.

There seems to be a marked difference in the prognosis of cases in which a portion of the cancer has been cut out for microscopic examination, and those in which the tumor has not been disturbed. The former have almost invariably died of metastases, even in cases in which the cancer was not in an advanced condition at the time of operation, while in the latter cases permanent recoveries have been made, especially since the introduction of radium and roentgen-ray treatment.

MACKAY, HUGH. Naevi and their treatment by radium. *Canad. M. Ass. J.,* May, 1924, xiv, 394–397.

The nevi are described and classified according to their morphologic characteristics and color. In treatment, carbonic acid snow is valuable for removing superficial vascular nevi. Radium is, however, the remedy of choice for this variety. For capillary nevi a 5 or 10 mgm. plaque protected with silk or rubber is moved over the involved area, allowing about 5 minutes for each square. Repetition of treatment should be made at intervals of not less than 6 weeks. The cavernous nevus may be treated with radium screened with 2 mm. of brass and held away from the skin a distance of about one inch. A more efficient method is the implantation of radium, which has very obvious advantages. Three or 4 months should intervene between treatments by this method. Spider nevi may be handled with radium applied topically, but CO_2 snow has been found more satisfactory.

QUICK, DOUGLAS. The treatment of intra-oral cancer. *Canadian Pract., Toronto,* March, 1924, xlix, 130–135.

In the operable group, radium is superior to surgery because it causes complete regression more frequently and with much less deformity of adjacent parts. In inoperable cases, radium and roentgen rays are responsible for some complete regressions and for a large measure of palliative relief in otherwise hopeless lesions. The combined method of dealing with the cervical lymph-nodes eliminates a large number of useless operations, produces better results in the strictly surgical neck and opens a new field of palliative relief in the surgically inoperable neck. These conclusions appear fully justified after experience covering one year. It remains to be seen what the future will show.

JOHNSON, FREDERICK M. Treatment of carcinoma of the antrum. *Canadian Pract., Toronto,* March, 1924, xlix, 136–140.

Experience in the treatment of 26 antral carcinomas is reported. The greatest obstacle to successful treatment of such cases is the failure of early recognition of the disease. Evidence shows that conservative surgery for the purpose of exposing the growth, combined with radium application will yield better results than radical operation. The disease is rarely if ever confined to the antrum alone. On this depends the method of surgical approach. Palliation is possible for the hopeless cases through the use of radium.

ALTSCHUL, W. Köhler's disease of the second metatarsus. *Med. Klinik,* Jan. 13, 1924, xx, 42–44.

Report is made of 6 cases, only 2 of which were caused by trauma. Inflammation or late rachitis was excluded in all. It is therefore assumed that this disease arises from alteration of the static condition. Thus, the head of the second metatarsus, exposed to increased pressure undergoes pressure necrosis at the epiphysis which ultimately breaks down. The regenerative processes originating in the metaphyseal periosteum start the reconstruction of the epiphysis. The susceptibility of the second metatarsus is explained by the fact that it is the highest point in the normal arch,

and that it is unable to support the unusual load in the sunken arch. It is possible that there is also present a constitutional weakness of the bones.

MASON, EDWARD H. The use of Lugol's solution in the treatment of exophthalmic goiter. *Canad. M. Ass. J.*, March, 1924, xiv, 219–221.

Experience indicates that through the use of Lugol's solution in true cases of exophthalmic goiter the pulse rate and metabolism can be lowered to normal in a few days. The clinical state returns to its former severity as soon as the iodine is discontinued. Exophthalmos disappears very slowly, but there is a tendency for the eyeball to recede with the decreasing pulse rate. Only long observation will determine if complete cure can be attained by this method. Five cases are cited to illustrate the control of toxicity by the use of Lugol's solution in this condition.

STRUTHERS, R. R. X-ray treatment of pertussis. *Canad. M. Ass. J.*, February, 1924, xiv, 141–142.

A report is given of results in 48 cases, aged 3 months to 30 years, treated by roentgen radiation. The treatment consisted mainly of a single large irradiation of the chest; and only a few of the cases received any other medication within a week after the treatment.

The results at present show that 7 cases, representing 15 per cent of the total, were promptly cured. Practical recovery from all symptoms was obtained within 24 to 48 hours. Relief was obtained in 20 cases, or 45 per cent. There was considerable amelioration of symptoms within 4 to 5 days in this group. Eighteen cases, 40 per cent, showed no appreciable change in their condition.

Despite incompleteness of the data, it seems quite evident that the larger the dose of radiation applied, the greater the improvement. The earlier in the paroxysmal stage the treatment is given, the greater is the probability of relief. No explanation can be given of the rationale of the treatment.

LINDBERG, GUSTAF. Atonic insufficiency of the stomach a cause of vomiting and of lack of appetite in infants. *Am. J. Dis. Child., Chicago*, March, 1924, xxvii, 197–203.

The type of vomiting referred to is the so-called habitual vomiting of infants. Roentgenoscopic observations have shown that the stomach of a normal infant differs from that of an adult both in shape and in function. Because of the absence of the peristaltic function the infant's stomach is like a flaccid balloon, changing shape and position according to the amount of its contents and the position of the baby.

In the case described, the roentgenologic evidence leaves no doubt that the inability of the stomach to empty itself normally when the baby was in the horizontal position was due to the absence of proper peristaltic function. When the conditions for emptying of the stomach were improved by the vertical position, the vomiting ceased.

These findings are not uncommon during the first weeks of life. The symptoms are vomiting, or lack of appetite, or both; and these symptoms may disappear when the baby is kept in a half erect position. These cases may simulate pylorospasm. Peristalsis visible through the abdominal wall may sometimes be observed without spasm or stenosis of the pylorus.

ROSS, S. G., and CROWDY, C. T. Tuberculous pyopneumothorax in an infant aged five months. *Am. J. Dis. Child., Chicago*, May, 1924, xxvii, 456–463.

This case represents what is believed to be the youngest patient in whom such a complication has been reported. The roentgen-ray examination was important in establishing the diagnosis, the presence of shadows at the hilum being observed quite readily. Parenchymal consolidation was also observed. This evidence in addition to a positive tuberculin reaction established the diagnosis. The evidence given by the roentgenograms was completely confirmed at autopsy.

ALTSCHUL, W. Ulcers of the outlet of the stomach. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, 1924, xxxi, 640–660.

The importance of the morphological changes of the bulbus duodeni is not denied, but the indirect, functional symptoms should not be overlooked, as the percentage of error when considering only the indirect symptoms is but slightly greater than in the "morphologic" method. Moreover, the indirect symptoms permit judgment of the intensity of the process, and therefore guide opinion as to the indication for operation. True organic stenosis of the pylorus and of the duodenum are differentiated from incomplete stenosis of the duodenum. The latter does not show the picture of a stenosis either clinically or roentgenologically, and is therefore termed astasic duodenal stenosis. The most important functional symptom is the intense, segmenting peristalsis starting high up in the stomach, occurring exclusively in affections of the stomach exit, such as florid ulcers and incomplete stenoses. It becomes more evident after addition of 0.05 gm. vanillin per meal, and does not occur in true stenoses and healed ulcers.

Duodenal motility is defined as active, but not segmenting, peristalsis following prompt filling of the duodenum. A truly patent pylorus is rare and occurs only in duodenal stenosis. In functional neurosis of the stomach deep, permanent contractions occur simultaneously. The 3-hour residue is considered much more important than the 6-hour residue in the method of studying this condition. A thin paste of bismuth is preferred, but barium has been used for the sake of economy. Citobaryum leaves the stomach too soon. Ulcers of the stomach exit produce the following symptoms, in addition to the ever-present segmenting peristalsis: (1) In simple duodenal ulcer, there is prompt filling of the duodenum, and persisting bismuth spot or 3-hour residue. (2) In pyloroduodenal ulcer, there is prompt filling of the duodenum, the bismuth spot is absent, but the filling residue is present. (3) In pyloric ulcer, there is no duodenal filling and considerable 3-hour residue. The astasic duodenal stenosis shows prompt duodenal filling, usually patency of the pylorus, and duodenal residue after 3 hours. Duodenal motility with persisting bismuth spot is a sign of compression of the duodenum by the liver (hepatoptosis or tumor). Adhesions to the duodenum, as a rule, show the picture of an astasic duodenal stenosis.

HENRIQUES, ADOLPH. Some probable functions of the spleen as demonstrable by the effects of radioactivity upon that organ. *N. Orl. M. & S. J.*, June, 1924, lxxvi, 534–537.

Application of radium or roentgen rays over the splenic area of the abdominal wall has resulted in beneficial effects in certain cases of myelogenous leucemia, pernicious anemia, Banti's disease and tuberculosis. The results were relief of capillary hemorrhage, increase of hemoglobin and red blood cells, reduction of leucocytosis and stimulation of immune bodies and of various organs. It therefore seems from the results that the functions of the spleen probably include the formation of immune bodies and stimulation of the hemostatic function as well as functions related to the red blood cells and pigment.

ASSMANN, H. The clinical diagnosis of multiple bone tumors. *Med. Klinik*, Jan. 27, 1924, xx, 108–111; 141–144.

Microscopic examination of osteoplastic carcinosis disclosed that the deposition of newly-formed bone takes place around the old, dead trabeculae. Osteoplastic carcinomas usually originate in prostatic tumors, and the osteoclastic usually in mammary and gastric tumors. Endosteal bone proliferation is the major symptom of the osteoplastic type. This proliferation is irregular, hence the washed-out, fluffy, irregular roentgenogram. In advanced cases, eburnation (with disappearance of the structure of the bone) finally occurs. In one case, all the bones of the back, head and parts of the extremities showed great shadow intensification; and autopsy disclosed carcinoma of the prostate.

The defects of the vertebrae in carcinoma are usually sharply circumscribed; and in tuberculosis they are fainter; but differentiation on these points alone is difficult. In osteoplastic carcinosis, it is important to determine the existence of a genuine diffuse osteosclerosis, the condensations of which are quite uniform in appearance.

AXMANN. Injurious radiations from radio electron bulbs. *Deutsche med. Wchnschr., Berl. & Leipz.*, April 18, 1924, l, 514.

Unilateral injury to the hair of the head was noted in the personnel of a wireless sending station. The injury consisted in lessened hair on the side toward the sending apparatus, and the scalp was slightly reddened, but there were no outspoken atrophic changes.

The effect is claimed to be produced by the radio amplifying tubes which are essentially minature cathode tubes with the grid acting as anticathode. This hazard is easily obviated by protection with a lead glass plate.

DESSAUER, F. The explanation of the biological action of radiation. *Strahlentherapie*, 1924, xvi, 208–221.

The following are some of the considerations which have led the author to his hypotheses of heat points: (1) the quantity of energy producing strong radiation effects is relatively minute and would be completely harmless in any other form; (2) absorption of roentgen rays by strong and weak electrolytes of various kinds and admixed with colloids resulted in no electrolytic changes; (3) prompt recombination of ions produced in solutions during the absorption of roentgen rays is undoubtedly the rule; (4) electrons are very much more effective in bacterial cultures than roentgen rays; (5) even after enormously excessive irradiation occasional cancer cells may still survive.

It appears to the author that in the train of events following an irradiation, there must be some place where the minute quantities of energy develop their tremendously large biological effect. In the transformation of the energy, heat must finally develop as the culmination of absorbed radiation. When a group of molecules at any point is mechanically agitated one may say that this position or this point is heated up. Those mechanical agitations which act on the molecules repre-

sent the final effect of the total absorbed energy. At first, only the molecules are affected which take part in the reaction (absorption of the agitation), and in the following instant the effect is transferred to the immediate vicinity, namely, the first neighbors colliding with the destroyed molecule; that is, in short, the creation of small points of active molecular movement or high temperature, termed by Dessauer "heat points." They are the positions where the intense energy of the radiation is transformed by electronic motion to general heat, in minute zones where the heat energy is highly concentrated, that is to say, must occur with high temperatures.

Dessauer assumes that this location and this phase of the transformations initiate the biological activity, although this is yet pure assumption. It may be, for instance, that heat points destroy cells, form chemically active substances, necro-hormones, and produce general effects. This hypothesis also explains the early reaction, and differences between hard and soft rays.

DESSAUER, FR. The nature of the action of radiation on the body. *Med. Klinik*, April 13, 1924, xx, 490–494.

An action similar to the photodynamic action in plants is too simple an explanation for the effects of roentgen radiation. In plants the radiation is absorbed at the surface, whereas the body is transparent, or at least translucent, to roentgen rays. The quantum theory of energy emission and absorption suggests a more plausible explanation. Quanta of roentgen energy probably activate electrons which produce the effects observed.

One school of thought believes that roentgen radiation acts through electrons by a process of sensitization. Others assume a catalytic action, or the production of electromagnetic fields, or electrolysis. These are all considered untenable suppositions. Careful calculation shows that rather few gram-calories of roentgen energy are needed to kill a man. It is believed that biological effects occur at those points where energy quanta are absorbed. This energy is transformed to heat and motion, i.e., translation of energy—a process quite general in nature.

It is believed that the start of the destructive roentgen-ray action (energy translation) is associated with gamma rays and light of short wave-length. Dessauer's hypothesis further assumes that the forces holding the particles of a molecule together are not increased by the energy applied. The rain of radiation produces here and there points of absorption (heat, etc.) resulting in changed chemical composition of molecules. Perhaps a few such altered molecules are enough to destroy a cell, otherwise the cell can recover.

This hypothesis explains the latency of and sensitivity to roentgen radiation, and other biological phenomena associated with radiations. Calculation shows that probably in general (subject, of course, to great variation) the destruction of 0.01 to 1.0 per cent of the molecular substance of a cell is very dangerous for it.

DRIESSEN, L. F. Sex gland injury by roentgen rays. *Strahlentherapie*, 1924, xvi, 656–689.

The question whether roentgen or radium radiations can injure sex glands was answered positively in experiments on rabbits, the results being opposed to those of Nürnberger on mice. In one case, the development of gestation products was inhibited by radiation; in another case, a 3-weeks old rabbit was intensively irradiated and pregnancy occurring in the 8th month resulted in maldevelopment of the embryo. In a third case, a roentgen irradiation of 10 minutes sufficed to delay the development of placenta and fetus in the pregnancy following. After irradiation of the head of a rabbit (10 minutes without filter), pregnancy lasted ten days longer than normal. Injury to the sex glands by radiation therefore undoubtedly occurs.

The author has had no experience with humans because he irradiates systematically only women over 40 years. Injury of the animal embryo by roentgen rays is a well-established fact. By unilateral irradiation of a rabbit, it was possible to destroy the pregnancy unilaterally. In general, strong irradiation during the first half of pregnancy inhibits the development of the embryo and the fetal placenta. Even weak irradiation (5 minutes) is inhibitory. Stimulation, i.e., acceleration of fetal development was not observed. The ovary of the gravid rabbit is less sensitive than the fetus. Injury of the fetus is immediate. In humans, there are 14 observations on children from mothers irradiated during pregnancy. Of these 14 children, one died in 2 days, one was mentally unbalanced, and a third had microphthalmia. Contrary to former views, it can now no longer be doubted that roentgen rays may be deadly to the human fetus.

Experiments on sex gland injury in young rabbits showed that the ovaries can be completely destroyed. The immature, young rabbit ovary is more radiation-sensitive than the completely matured one. Similar conditions may be operative in humans. Roentgen rays are a sex-gland poison, and the irradiation of young women is dangerous for the procreative ovary.